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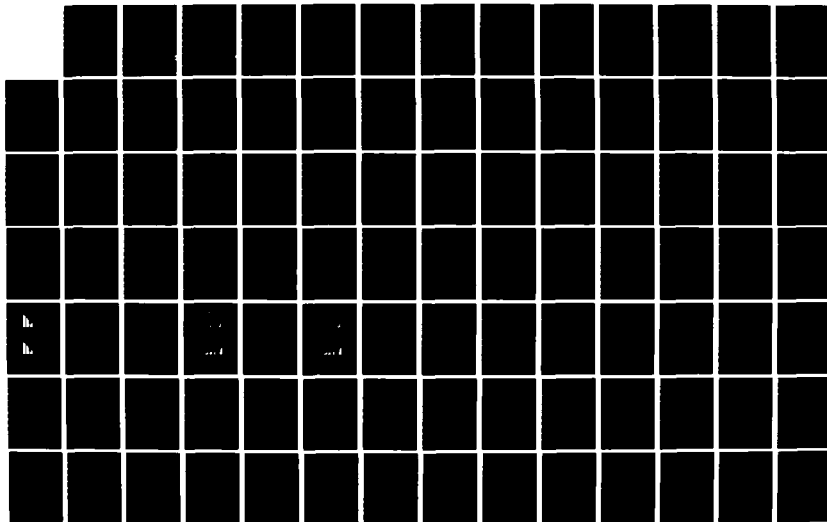
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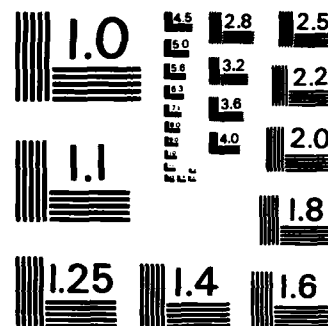
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A SIMULATION MODEL TO EVALUATE
MULTIYEAR PROCUREMENT ECONOMICS
FOR SPARES ACQUISITION

THESIS
ALBERT F. BODNAR JR., GM-13

AFIT/GSM/LSP/855-2

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DEPARTMENT OF THE AIR FORCE
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Wright-Patterson Air Force Base, Ohio

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**A SIMULATION MODEL TO EVALUATE
MULTIYEAR PROCUREMENT ECONOMICS
FOR SPARES ACQUISITION**

THESIS

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the

Requirements for the Degree of

Master of Science in Systems Management

Albert F. Bodnar Jr., B.S.

GM-13

September 1985

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Preface

The purpose of this thesis was to develop an approach to evaluate the economics of applying Multiyear Procurement (MYP) contracts on spares acquisitions. Simulation modeling was applied to develop a model that is flexible and can be used on all weapon system programs. Data used in the development and application of the model was based on the B-1B program.

Results from the study showed that anticipated savings levels matched against possible engineering change costs are the two primary cost drivers in this decision. Other considerations include administration, transportation, and storage costs. A major finding is that whether a MYP decision is appropriate depends on the weapon system program itself, including the size of the weapon system buy and the scenario the system will be operated.

I am deeply indebted to many people who helped and guided me through this research. I give great thanks to my advisor, Captain John A. Campbell, D.E., who spent many hours and months keeping me on track. Special thanks goes to my reader, Mr. James R. Callahan, who developed the research idea and guided me through the entire research process. In addition, many people in the B-1B SPO, too many to mention, deserve special thanks for obtaining needed data and putting up with my continuous questions. A special appreciation goes to Mr. Porter Osby for his personal efforts in collecting contractor data and providing me with his thoughts and ideas.

Finally, I wish to thank my wife, Kathy, and my son, Jacob, who put up with me through this last year.

Albert F. Bodnar Jr.

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List of Acronyms

1. AFIT - Air Force Institute of Technology
2. AFLC - Air Force Logistics Command
3. AFPRO - Air Force Plant Representative Office
4. AFSC - Air Force Systems Command
5. ALC - Air Logistics Center
6. ASD - Aeronautical Systems Division
7. AWACS - Airborne Warning and Control System
8. DOD - Department of Defense
9. DSCS - Defense Satellite Communications System
10. EAB - Expanded Advanced Buy
11. ECP - Engineering Change Proposal
12. GAO - Government Accounting Office
13. LRU - Line Replaceable Unit
14. LSA - Logistics Support Analysis
15. MTBD - Mean Time Between Demand
16. MYP - Multiyear Procurement
17. NRTS - Not Repair This Station
18. OSD - Office of the Secretary of Defense
19. QPA - Quantity per Aircraft
20. RSP - Radar Signal Processor
21. SAIP - Spares Acquisition Integrated with Production
22. SPO - System Program Office
23. SRU - Shop Replaceable Unit

Abstract

The purpose of this research was to evaluate the economics of applying the Multiyear Procurement (MYP) contracting approach on spare acquisitions. Evaluations have been performed documenting upfront savings with the use of MYP. Savings have been shown in the areas of material purchases and inflation avoidance. However, no research has looked into the downstream cost implications associated with MYP. The B-1B program issued MYP contracts for many of their spare requirements in order to obtain the expected benefits. This research concentrated on selected items covered in those contracts. The risk areas were determined to be costs associated with engineering changes, transportation, storage, program changes, and quantity adjustments. A simulation model was developed that can be used on any weapon system program to evaluate the benefit/cost relationships of MYP. Findings were that the two cost drivers in the MYP decision are the expected upfront savings compared to the expected engineering change costs. In addition, this research has shown that while MYP is appropriate for some items, it is not the correct approach for all items. The decision must be evaluated on each weapon system program individually. The simulation model provides this capability.

A SIMULATION MODEL TO EVALUATE MULTIYEAR PROCUREMENT ECONOMICS FOR SPARES ACQUISITION

I. Introduction

General Issue

Spare parts acquired to support military defense systems are becoming increasingly expensive. The majority of the Air Force spare's budget is used to support aircraft systems (17:41). It is projected that the Air Force will spend 6.5 billion dollars in fiscal year 1985 alone for aircraft spares (17:41). Since the dollars are big, the Department of Defense (DOD) is closely watched by the public on its spending habits. Several stories have made headlines which attempt to discredit DOD on their parts acquisition programs. The job of managing the Air Force's spare's program is tremendous considering the 7800 aircraft that the Air Force Logistics Command (AFLC) must manage. An F-16 aircraft has 250,000 spare parts alone which must be managed (17:41). Since the job of managing Air Force assets and the dollars involved are so large, the Air Force and DOD are continually researching ways to lower the spare part's budget. The bottom line is to be more efficient in its buys and more effective in its support.

Spare parts for new Air Force systems are acquired using the Air Force provisioning process. Provisioning is the process of evaluating,

determining, and cataloging specific information on every part that enters the Air Force inventory. This information is used to manage the parts over its life cycle. The information includes item characteristics, procurement methods, and support methods, just to mention some of the data which is collected and cataloged on each item. The forum where provisioning occurs is a provisioning conference that can take place at either government or contractor facilities. The provisioning conference is where government and contractor experts meet face-to-face to review supply support data. This process is quite involved considering the large quantity of parts that are reviewed, especially on a new aircraft program.

While most of the time in a provisioning conference is devoted to cataloging actions, three important related elements are finalized at a provisioning conference: the maintenance repair level, the maintenance factor, and the quantity of spares to be bought. The maintenance repair level and the maintenance factor impact the entire logistics requirements for each new part. For example, the types of support equipment, the training requirements, the technical manuals needed, and supply support levels (i.e. quantity of spares) are all impacted. The repair level can either be organizational, intermediate, depot, or a combination of all. These levels are referred to as the Air Forces's three levels of maintenance.

Organizational level maintenance is also referred to as on-equipment maintenance, i.e. repair is accomplished without removing the item from the aircraft. Intermediate level maintenance is performed at base level. This level of maintenance is assigned if it is determined to be beneficial to the Air Force. Depot level maintenance is either performed at government or contractor facilities. The level or levels of maintenance selected for an item has direct impacts on supply support requirements (spares) due to the

different repair and shipping times associated with each method of repair.

The other key provisioning element is the maintenance factor. The maintenance factor is an estimate of the number of maintenance actions that an item will need for a specific period of time such as the number of removals per 100 flying hours. The inverse of the maintenance factor multiplied by the time period is commonly referred to as the mean time between demand (MTBD). (For example, a maintenance factor of 1 equals a MTBD of 100 if the base time period is 100 flying hours.)

Prior to the provisioning conference the contractor develops an initial estimate of the maintenance factor and the maintenance concept (level of repair) on every item. These estimates are made using a very systematic process called the logistics support analysis (LSA) process. This process includes performing an engineering analysis and a comparative analysis on existing similar parts for every new item that enters the Air Force inventory. LSA also insures that all logistics elements are compatible and that logistics issues/concerns are considered during engineering design. At the provisioning conference these estimates are reviewed and adjusted by Air Force equipment specialist who are members of the provisioning team and work for an AFLC Air Logistics Center (ALC). The equipment specialist reviews the contractors estimates and concepts by comparing the design of each item with historical knowledge of similar items. Changes made at a provisioning conference can be significant since the entire maintenance concept may be changed. All changes must be reviewed through the LSA process to insure that the final logistics system is compatible. This problem is more significant on a concurrent program (i.e. design and production are ongoing simultaneously), because some logistics elements (e.g. support equipment) may have already begun development prior to

provisioning.

Another element that affects spares quantities is the operating scenario. This scenario is provided by HQ AFLC in the form of a programming checklist. The programming checklist specifically states the number of aircraft and the flying hour profile that is to be used to determine initial spares requirements. The total spares requirements for a system is determined by the maintenance factor, maintenance concept, and operating scenario the system is operated. This scenario consists mainly of the total number of aircraft, the operating hours per year, and the number of bases. However spares are usually only acquired to support a fraction of the fleet, to protect the Air Force from acquiring too many assets, which is stated on the programming checklist. Since only a fraction of the fleet is initially supported (only a fraction of the fleet is delivered and requires support early in a program), the initial spares requirements would be very low. However parts do fail more often when first delivered (infant mortality) so the equipment specialist will generally derate the maintenance factor by a constant factor on new items to determine initial requirements and subsequent spares order (6).

Air Force Logistics Command Regulation 65-1, Part One (4) provides guidance regarding provisioning fundamentals. Chapter one, Principles, states the factors which must be considered. Some key factors are:

1. Unknown true failure rate of parts.
2. Unknown design changes.
3. Possible program changes.

The problem is that each buy of spares will be relatively small, even

taking into account the maintenance factor adjustment for infant mortality. Usually, the programming checklist only allows the Air Force to acquire spares for a fraction of the total expected fleet, therefore the computed requirement of each item will be very low or none at all resulting in small spares buys. This spares procurement practice results in inefficient contracting methods. The contractor is only awarded Air Force spares contracts for small quantities. In addition, future small contracts will also be necessary to support the system as the fleet grows.

Methods have been developed by the Air Force to reduce this inefficiency. One method is called spares acquisition integrated with production (SAIP) and is detailed in Air Force Regulation 800-26 titled, Spares Acquisition Integrated With Production (10). The SAIP concept is to award the contractor the initial spares order through the production contract on the system itself. This method lowers spares unit pricing because the order is made concurrently with production (installs) orders. Savings result from larger buys and fewer administrative burdens. Unfortunately, neither the contractor nor the government is usually ready to establish spares requirements on a timely basis. The spares requirements must be established before the production contract is finalized, but it takes time for the contractor to estimate realistic failure rate projections, develop a maintenance concept, develop and provide provisioning technical documentation, and schedule provisioning conferences to cover the large quantity of items that comprise a new weapon system. Also, the government has an equally hard task of justifying and obtaining necessary funding to support the requirements. These problems have resulted in limited use of SAIP.

Another method to further reduce unit acquisition costs is multiyear

procurement (MYP). MYP is a contracting approach that extends contractual coverage on a program beyond one year. Cost reductions are possible with MYP by initially procuring enough spares (i.e. larger and more economical lot size buys) to support the entire fleet. Savings are obtained with quantity discounts that surpass even SAIP savings due to even larger buys. However, the Air Force must be willing to accept several risks with MYP (e.g. engineering changes causing obsolescence or higher retrofit costs, overbuy due to pessimistic maintenance factors, program changes, and program cancellation).

It is important to note that some Air Force acquisition methods have been developed to reduce spares acquisition commitments due to the above risks. One method is phased provisioning which delays Air Force acquisition of spares. However, while savings have been shown on high cost/unstable design items, the government does lose economic ordering advantages (16:4-8). Of course, MYP has the same timing problem (establishing requirements early) as SAIP, but has the additional benefit of a larger economic quantity.

Specific Problem

The B-1B System Program Office (SPO) obtained Office of the Secretary of Defense (OSD) approval and funding to use the MYP contracting approach to acquire spares. This approach was approved to obtain lower unit parts cost which results in savings to the government. The initial B-1B programming checklist authorized the initial acquisition of enough spare parts to support only seven B-1B's. Even though maintenance factors

were adjusted at provisioning conferences to account for infant mortality and contractor optimism (usual maintenance factor adjustment for avionics items is to double the failure rate), the buy of spares was still very limited. With OSD approval, the support base was raised from seven aircraft to ninety-nine aircraft. This change allowed the program office to acquire enough spares to support the entire projected fleet of B-1B's. The B-1B SPO estimated savings of \$100 to \$200 million (20% or more savings of total spares buy). These savings include cost reductions from the four B-1B associate contractors (Rockwell International, Boeing, AIL, and General Electric).

However, the Air Force is facing several downstream risks including:

1. Engineering change proposals (ECP) which will impact retrofit costs or cause obsolescence. ECPs are approved to correct deficiencies found during testing or to improve either performance or logistics capabilities.
2. Schedule impacts that may require the Air Force to take early delivery of assets that could have storage impacts.
3. Incorrect maintenance factor estimate which could cause an underbuy or overbuy of spares.
4. Program changes that could impact the entire logistics system.
5. Program cancellation.

The problem is two-fold. First, the projected savings have yet to be

validated. Second, risks from using MYP have yet to be addressed. Upfront cost savings have been validated on past programs. However, no studies have evaluated the downstream risks. This evaluation is the purpose of this research.

Scope of Research

This research concentrates on the Boeing spares contracts to assess the MYP savings compared to the downstream risks. The Boeing contract was selected because their items cover a wide spectrum (i.e. low cost/high reliability to high cost/low reliability items), data availability, and they are scheduled to complete provisioning first. In order to obtain a detailed evaluation, a sample of items was chosen since it would be impossible to evaluate all the thousands of parts that comprise a B-1B. The selected items include simple, moderate, and complex parts. This sample correspondingly includes low and high cost parts. The intent of the research is to evaluate the savings that must be achieved in order to outweigh the risks taken and to evaluate whether MYP savings are different on low cost/technology parts than high cost/technology parts. Selected items include:

1. Radar Signal Processor
2. Station Logic Unit
3. Computer Control avionics
4. Power Supply, Controls and Displays
5. Electronic Display Unit
6. Radar Processor Video Signal

7. Control Jettison

8. Indicator, Multi-function Display

Hypothesis

The hypothesis that this research investigates is:

MYP is a cost-effective approach for acquiring spares.

This research evaluates the impact of the MYP risks as discussed previously that are associated with utilizing MYP to achieve lower unit pricing on spare parts.

Research Questions

The thesis evaluates the following factors:

- 1. What are the cost drivers associated with a MYP decision?**
- 2. What are the cost impacts due to the item's spares requirements?**
- 3. What are the cost impacts of engineering changes?**
 - a. Implementation costs.**
 - b. Number of changes.**
- 4. What are the cost impacts due to quantity adjustments?**
 - a. Increased buy.**
 - b. Decreased buy.**
- 5. What are the inflation impacts?**
- 6. How sensitive are the upfront savings levels?**

7. Are some types of items better suited for MYP than others?

- a. Price levels.
- b. Technological complexity.
- c. Buy quantity, i.e. failure rate sensitivity.

Methodology

Introduction. In order to fully evaluate and assess whether MYP savings will be realized on the B-1B program, both the acquisition savings must be validated and the downstream costs must be evaluated. This research will evaluate the downstream costs of buying all supply support requirements early in the B-1B life cycle versus using normal initial provisioning techniques and acquiring the remaining supply support requirements later. The problem associated with validating the acquisition cost savings are also addressed.

An effective method to evaluate the upfront savings due to MYP is to have two proposals to evaluate and compare to each other (annual procurement and MYP). Unfortunately, this is an expensive method and reduces potential multiyear benefits due to the expense associated with the contractor developing two proposals. Mr. F.S. Belyea of the Singer Company stated:

The practice of requiring two full cost proposals, for comparative purposes, one for MYP and one for an annual buy, adds significantly to contractor expenses, is completely at odds with indirect cost cutting efforts and is unnecessary once a program is justified to fit a MYP profile [5:117].

The B-1B program did not have two spare's proposals to evaluate and compare. Even if two proposals were available, the problem of contractor gaming is always present (i.e. making the type of contract that the contractor desires, look the most favorable).

However, the B-1B SPO is pursuing a validation effort with Air Force Plant Representative Office (AFPRO) personnel representing each associate contractor and Air Force Systems Command (AFSC) personnel who are responsible for Aeronautical Systems Division (ASD) MYP actions. In addition, the final contracts for the B-1B aircraft itself is using the MYP technique and two different contracts were proposed (annual procurement and MYP) by each associate contractor. Both contracts were evaluated by SPO personnel so a comparison was possible. The MYP contract was chosen. Therefore, the spares contract validation effort can piggyback on this effort.

A review of the literature on MYP experience did show that savings can be expected ranging from 1.4% to 25% depending upon the groundrules (reference Chapter II, Table 1). It is noted that the 25% savings computation is based upon spares savings for the C-2A program. The B-1B SPO estimate of 20% savings does fall within this range. The bottom line is that once a program has been chosen as a multiyear candidate, government personnel must professionally evaluate the contract to insure that the government is receiving the benefits entitled. This requires implementing good factfinding and negotiating procedures.

Evaluating Downstream Government Risks. The hypothesis of this research is that life cycle costs are lower when using MYP to acquire spare parts than if normal initial provisioning techniques are implemented. The entire benefit achieved from MYP is lower acquisition prices on parts, but as

presented, the Air Force is accepting several downstream risks which includes additional retrofit costs or even obsolescence, quantity overbuy or underbuy, and increased storage costs. The upfront acquisition cost savings also depend upon several factors including upfront savings realization and avoiding inflation. (Inflation avoidance depends on inflation being present. Inflation is one area advertised as a main area of MYP cost savings. Inflation was quite high when the B-1B MYP plan was formulated, but inflation has been reduced in recent months. Inflation is an area where sensitivity analysis is performed in this research.) The interactions of these elements are shown in Figure 1.

The interactions are complicated by the fact that a multiyear contract can be issued for varying amounts of time, that could impact any benefits. Add to these interactions the fact that aircraft systems have a myriad of different types of parts in all price levels, complexities, and reliability levels (i.e. number of spares actually needed), and the analysis regarding the hypothesis becomes quite complex.

In order to properly evaluate all of the interactions involved, a computer simulation model was developed. A review of existing algorithms and models indicates that no work or research has been done to quantify MYP downstream risks. An AFIT thesis on MYP completed by Breary recommended that research be initiated on quantifying the stability needed for a program to be justified for MYP (8:122). This fact is probably a result of the relative newness of using MYP on major programs in the Air Force. Simulation modeling was chosen over traditional mathematical accounting or regression models due to the flexibility and relative ease in programming complex interactions that is the foundation for simulation. The problem that this research is attempting to provide insight into lends itself to

simulation modeling.

MYP Benefits

Risk Areas

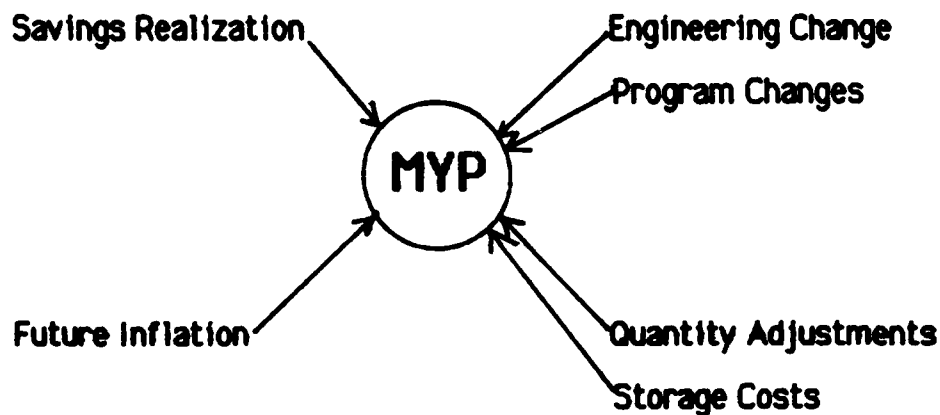


Figure 1. MYP Interactions

Chapter II discusses some of the history of both MYP in general and the B-1B MYP program for spares. Chapter III explains the operation of the simulation model developed. In Chapter IV, an analysis of the selected MYP items is demonstrated with the MYP simulation model. Finally, Chapter V summarizes the analysis and provides recommendations for further study.

II. Background Information

Multiyear Procurement Background

Introduction. MYP is a contracting methodology that extends contractual coverage on a program beyond one year. Rasch and Brearey interviewed managers at Aeronautical Systems Division (ASD), Wright-Patterson Air Force Base, and stated, "MYP was not merely a contracting method, but an acquisition strategy" (18:50). This definition extends the idea of MYP as a contracting approach needing early consideration on new systems, since one of the first issues facing a new systems is determining the acquisition strategy. In addition, this definition implies that MYP is not a panacea for weapon system cost growth and MYP applications may not be appropriate on a particular acquisition.

The usual Air Force contracting method is single year contracting (contracting for one year). This method ties the contract to the budget cycle and gives the Congress and the Air Force the greatest flexibility with the control of funds, since the Air Force must obtain contract/budget approval each year. However, on programs that span several years, criticisms have been raised that this approach is the most inefficient due to smaller production-lot buys.

Key contracting terms regarding MYP are multiyear funding, annual funding, and full funding. Multiyear funding authorizes the appropriation of funds on a contract beyond one year (18:40). Annual funding is authorizing funds for one year (18:39) and is associated with single year contracting. Full funding is a policy of DOD that stipulates that complete funding must be

appropriated (available) on a contract before the contract is awarded (18:40). The full funding concept has major implications in the use of MYP because this policy severely limits Congress's control of DOD weapon system funds once a program is approved. The military budgeting process is very complex and the new weapon system programs that are being developed are often pushing the state of the art in technology. Congress is not willing to relinquish their control of weapon system developments on programs that could face technical/cost problems downstream, unless the benefits are proven to outweigh the risks. In addition, all weapon system programs have political impacts which further complicates DOD's power to introduce acquisition procedures that limits Congress's flexibility.

The idea behind MYP benefits are not new (buy in large quantities and receive a lower unit acquisition price). Most new weapon systems are acquired using annual year contracts, even though production may span many years. This results in the requirement for the Air Force and the contractor to negotiate contracts each year instead of one contract covering all production requirements. The Air Force loses all benefits of economic ordering. The contractor is not willing to acquire materials in bulk because of the high probability of contract changes which is prevalent today. As a result, MYP use in the Air Force has been limited and Air Force acquisition and logistics managers have limited knowledge on both the benefits and risks associated with MYP. Any new idea that changes the way of doing business must go through a learning phase. MYP is now going through an educational period in the the Air Force, especially in the logistics community where procedures to obtain support for a new weapon system are strickly established. Most of the reluctance with MYP is the problem with Congress regarding funding flexibility. The Air Force has been using

single-year procurements for decades. MYP is now an alternative approach that is supported by DOD and industry because of the potential cost savings and program stability effects.

MYP History. Although there is little DOD history of using MYP, MYP contracts were issued during the 1960s mainly for supplies and services. DOD was successful in implementing those contracts (18:45-46). However, in 1972 the Navy had a multiyear shipbuilding contract, but was forced to cancel the program. An important MYP consideration is termination liability. Dr. Singer and Colonel Brabson define termination liability as "the maximum cost the government would incur if a contract is terminated" (20:126). Related to termination is cancellation. Cancellation occurs when the government does not fund future years' requirements on a contract (20:125). Since MYP contracts cover several years, the cancellation costs of a program could be large. The Navy cancellation costs on the ship building program totaled over \$388 million causing Congress to place a \$5 million cancellation ceiling (18:46-47) on MYPs. The cancellation ceiling reduces risk to the government and increases risk to the contractor. This action eliminated the use of MYP on major acquisition programs. If this cancellation ceiling was in effect during the Navy shipbuilding program previously mentioned, the contractor would have lost \$383 million dollars. Weapon system contractors are not willing to accept such high risks.

Nonetheless, in 1978 the Army tried to implement a 5-year production contract for the production of 500 tanks. The Army was unsuccessful due to the cancellation ceiling of \$5 million (20:116-117). The use of a cancellation ceiling, which represents only a fraction of the production contract, places large risks on the contractor. Not many contractors will have the resources to cover such a loss in the case of

contract termination. The result is that while MYP was intended to increase stability and competition, MYP actually decreased competition since most contractors found the risk unacceptable and would not propose on this type of contract.

Current MYP Policy. While the benefits of MYP were obvious, the risks of cancellation were considered by industry to outweigh those benefits. On the other hand, Congress and DOD did not want more unfavorable publicity, as resulted with the Navy shipbuilding contract cancellation. Military spending always receives a great amount of attention, especially on programs that run into technical/cost problems. However, one of the problems with single-year contracts is the year-to-year changes, such as stretching out a program (lowering the yearly production rate). Contract changes promote instability and results in costs increases or even possible cost overruns. A major advantage of MYP is increased program stability since both the contractor and the government get locked into a contract. So while MYP use declined due to the possible cancellation costs, cost growth due to production rate changes continued on major programs. General Alton D. Slay stated, "since the 1960s, not a single contract has been procured according to its original schedule" (22:22). Schedule changes usually result in program stretch-outs that result in a higher unit acquisition price, the problem MYP solves. General Slay said that the F-15 program costs increased \$1.68 billion due to changes in schedule and the F-16 program costs increased \$2.5 billion due to program delays (22:22).

Congress and DOD found themselves in a dilemma. MYP benefits were known but policy placed too much risk on industry, so MYP use declined. Policies that needed changing were the cancellation ceiling requirement (\$5 million) and the full funding requirement (entire contract funds must be

available).

Cancellation Ceiling. The cancellation ceiling on MYP contracts was \$5 million and only covered nonrecurring costs (20:117). Nonrecurring costs are those resources used that are not related to production quantity such as engineering and design. Recurring costs relate to costs that are directly related to the quantity produced such as materials. This stipulation that only nonrecurring costs are covered is very important. Lower unit acquisition price is obtained from the contractor making a larger investment in materials (buying in quantity) and also from the contractor investing in a more stable workforce (22:22) (keeping people so that learning curve benefits are not lost). However due to policy, recurring costs such as a material investment, were unrecoverable if the program was terminated. This policy made contractor risks even higher on a multiyear contract.

In the FY82 Defense Authorization Bill, the cancellation ceiling was raised to \$100 million and covered both nonrecurring and recurring costs (7:48). This change in policy significantly reduced contractor cost risk. Since the change now allowed for recovery of recurring costs, industry would be more willing to invest large material quantities so that unit prices could be reduced. General Slay stated that:

Perhaps the most important long-range benefit of multiyear procurement is that it encourages contractors to increase their capital investment. Long term, stable requirements provide better opportunities for recovering investment costs. They also allow contractors to obtain more favorable loan term and to spread the cost of productivity enhancements over a larger base [22:22-23].

Full Funding Policy. The full funding policy states that before a contract can be awarded, all funds must be available unless an exception has been authorized (20:125). This policy created the term, multiyear funding, which means obligating funds for a contract covering several years (20:126).

The problem with the full funding policy is that funding flexibility is greatly limited, since funds are obligated for several years that could be used on other programs. However, General Slay points out that full funding is not a legal requirement (22:23), but only policy. General Slay promoted the argument that termination liability funding, instead of full funding, should be sufficient to protect DOD from costs resulting from program cancellations. Funding flexibility increases, since less funds would be obligated under the termination liability concept (22:24). This idea has brought the term enhanced MYP. Singer and Brabson state:

Recently, industry has also backed off from multiyear funding and adopted enhanced multiyear procurement as a fall-back position, chiefly because of the realization that Congress is highly unlikely to approve multiyear funding in the foreseeable future and that enhanced multiyear procurement (with a high cancellation ceiling) can accomplish almost as much as multiyear funding.
[20:117]

In contrast, Harshman stated that classical MYP is still favored (contracting for several years requirements), but using annual funding (13:27). This method protects the contractor's nonrecurring cost investments and includes protection of recurring cost investments in the outyears. On the other hand, Harshman does state that the termination

liability funding concept is gaining support. The advantage of termination liability funding is the reduced amount of dollars that are tied up on a contract (13:27).

Program Criteria for MYP. DOD policy has changed in order to obtain the benefits from MYP. As previously stated, MYP is not a panacea to reduce costs on all programs; and if misapplied, could possibly increase costs. For example, unit prices have actually gone down on some commodities such as calculators and personal computers. Lafors and Rasch/Breary present six criteria for using MYP:

1. Benefit to government (savings are quantifiable).
2. Stable requirement (low risk of cancellation).
3. Stable funding (MYP funding must be identified in five-year defense plan).
4. Stable configuration (technology stable).
5. Cost confidence (firm-fixed price or fixed price incentive contract).
6. Confidence in capability (does the contractor have capability to perform). [15:57:18:49]

All six criteria should be evaluated before a MYP decision is implemented. Lafors goes on to state some special MYP considerations. For example, a program in development may be unstable and instability may continue for the first and second production-lot buys. However, stability does increase as engineering development continues, and while MYP may not be initially desirable, MYP could be implemented on follow-on requirements (i.e., production-lot three, four, etc.) (15:58). Lafors also provides special clauses that could be implemented to cover:

1. Exceptional increase or decrease of the contractors business base.
 2. Variations in quantity.
 3. Notification clauses (prior to changes in plans to buy advance materials).
 4. Configuration changes.
 5. Cost performance reporting.
 6. Variable progress payments.
 7. Economic price adjustments.
 8. Higher profits.
- [15:59-60]

MYP is still changing and refinements in its use continue as additional experience is obtained.

MYP Experience. Harshman states that the FY83 budget and outyear programs has been based upon attaining an estimated savings of \$1 billion from MYPs (13:28). Harshman further states that \$546 million has been added to the FY83 budget in order to obtain these savings (13:27). Table I shows the programs that Harshman is referring to.

General Skantz believes that the Air Force will save more than \$2.5 billion from implemented MYPs. However, General Skantz also emphasizes that Congress has denied approval on almost all MYP candidate programs in the 1984 budget (21:4), due primarily to continued Congressional skepticism of MYP benefits and a reluctance from Congress to approve programs that require multiyear budget obligations.

Table II displays expected MYP savings as a percentage of total contract price on several programs. As shown, savings expectations range from 1.4% - 25%. A rational interpretation of these figures is difficult due to the different methodologies and groundrules involved. For example, the low estimates were the result of the General Accounting Office (GAO)

TABLE I
MYP Programs

	(\$ in millions)	
	FY83 Increase	5-Year Savings
C-2 Aircraft	32.4	58.4
SM-1 Missiles	48.1	62.7
EA-6B Aircraft	9.1	25.2
A-6E Aircraft	5.0	25.6
NATO SEASPARROW Missiles	9.0	37.2
MULE Laser Designators	10.5	5.5
T-AO Fleet Oilers	109.8	66.5
MK-46 Torpedoes	34.5	38.1
CH-53E Helicopters	29.9	44.8
DMSP Satellites	30.7	49.3
NAVSTAR GPS	-	249.3
MLRS Rocket Systems	53.2	111.3
BLACKHAWK Helicopters	159.2	81.1
ALQ-136 Radio Jammers	<u>14.5</u>	<u>38.2</u>
	545.9	893.5

[13:27]

using discounting procedures. Discounting procedures are preferred by the GAO to evaluate cost savings because discounting accounts for the time value of money. High estimates, on the other hand, recognize then-year dollar differences.

Additionally, some MYP savings projections have been identified by comparing single-year versus multiyear proposals while other savings projections were developed by questionnaires. Regardless of the methodology involved, Table II illustrates that multiyear savings are significant.

TABLE II
Estimated Savings on Programs With Use of MYP

Simulator Program	10% [5:116]
C-2A Program	11.67%
C-2A Spares	25.0% [11:192]
Global Positioning System	
Program Office Estimate	13%
GAO Discounted Estimate	1.4% [25:4-5]
Black Hawk Helicopter	
Army Estimate	7.2%
GAO Discounted Estimate	4.6% [23:6 Appendix I]
KC-10	15.6% [19:59]
F-108-CF-100 Engine	4.5% [19:59]
30 MM Ammunition	11.7% [19:59]
B-1B	10.0% [19:59]
F-16	8.9% [19:59]
T-46A	3% [9:80]

Table III shows results from an Air Force Institute of Technology (AFIT) master's thesis that examined the areas where savings are obtained with MYP (19:62). As shown, 70% of savings are obtained through materials savings and inflation avoidances. Sikorsky corporation maintains that 90% of savings are through materials savings and inflation avoidances (23:5 Appendix 1). More recently the GAO has completed a review of MYP candidates for the FY1985 budget. Three Air Force programs were selected (also seven Army and two Navy programs were selected). The Air Force programs are the F-16 airframe, F-16 simulator, and Defense Satellite Communications System (DSCS) with discounted savings respectively at 6%, 4.2% and 15.1% (24:12). Four Air Force programs (F-16 radar, AN/ARC-170 radio, Airborne Warning and Control System (AWACS), and low-level laser guided bomb) were rejected for MYP use due to either an unstable configuration (F-16 and laser guided bomb), an unstable requirement (AWACS), or that savings were insufficient (radio) (24:9). In addition the GAO evaluated the areas of savings attributable to MYP on these programs. Table IV shows their results which are in agreement with previous research.

MYP has proven benefits if properly applied, but the Navy cancellation costs that were incurred in the 1970s should not be forgotten. While Congress still shows reluctance in approving MYP use on major programs, changes in procurement policy have been made (\$100 million cancellation ceiling, termination liability funding) that will allow industry to accept the risks associated with MYP. Education is needed for DOD managers to insure that proper applications of MYP are made. Harshman states:

The new multiyear procurement concept is one that the Comptroller family must understand in order to provide the effective communication and policy implementation

TABLE III
Elements of MYP Savings

Average % of Total Cost Savings

Manufacturing	18.6%
Design/Engineering	8.1%
Vendor Procurement/Raw Materials	41.1%
Inflation Avoidance	29.3%
Tool Design	2.9%
[19:62]	

TABLE IV
GAO MYP Savings Study

Source of Savings	%of Total Savings
Inflation	30.6%
Vendor procurement	47.9%
Manufacturing	17.0%
Other	4.5%
[24:13]	

into current directives. Awareness of this concept will be especially important to our accountants, auditors, and budget personnel [13:28].

The logistics community is also supporting the MYP concept. Dr. Webster, Deputy Assistant Secretary of Defense for Logistics and Material Management states:

We are therefore encouraging the military departments to use multiyear contracts in obtaining spares, and we are encouraging the logistics centers and inventory control points to apply mutiyear contracting in all other pertinent areas of logistics [28:7].

Industry is also supporting MYP. Hughes and Northrop are leaders in promoting the MYP concept. Northrop has stated that \$10.6 million was saved on the B-52 AN/ALQ-155 power management system due to labor and material savings obtained from MYP (18:44).

With continued emphasis on MYP by industry and DOD leaders, the future of MYP looks good. The Air Force must carefully apply MYP on those programs that will provide the greatest benefit in terms of cost savings, since it is highly unlikely that Congress will appropriate all available funding. As long as MYP is not misapplied, MYP will be approved on more programs. All military managers need to understand the advantages and disadvantages of MYP.

B-1B Background

The B-1B program is a high visibility program. The GAO reviewed the

logistics aspects of the program and made several recommendations, one of which was to implement SAIP to reduce the costs of spares.

The GAO concluded that a 10%-20% reduction in spares costs could be attained (24:16;3:16) if SAIP procedures were employed. The B-1B System Program Office (SPO) agreed with the GAO that savings are possible with the use of SAIP (3:21). The B-1B production contracts for the remaining lots were being negotiated based on using MYP, so it was recognized by the SPO that even bigger savings were possible using MYP for the spares buy than just from employing SAIP.

In July 1983, the B-1B SPO formulated a multiyear contracting approach for acquiring spares. This approach included using SAIP advantages combined with MYP additional advantages. The approach was labeled "expanded advanced buy" (EAB). In August 1983, the B-1B SPO investigated a strategy with the B-1B associate contractors to accomplish the EAB initiative. One of the major obstacles for success was that the provisioning conference schedule was not compatible with the EAB/MYP milestones.

The agreement reached among the SPO, the Oklahoma City ALC system program manager for the B-1B (and lead provisioning office for the B-1B program), and the B-1B associate contractors was to accelerate the entire provisioning schedule. The acceleration was effectively a one year acceleration.

This agreement placed tremendous pressures on both contractor and Air Force personnel. The contractor was required to make recommendations on each item's maintenance level or levels and estimate each item's maintenance factor (i.e. mean time between demand (MTBD)) prior to planned completion of the LSA process. This made the provisioning of spares and the

identification of other logistics resources (support equipment, technical data, etc.) even more difficult. This was not an easy task considering the large quantity of parts that are involved. In addition, each part must be reviewed by government experts and many changes occur. The challenge for the contractors and the SPO was to insure that all logistics elements remain compatible after all the changes are made, and to insure that the maintenance concept and maintenance factors on all the items are correct, since the intent was to acquire complete spares support for the B-1B. Any gross errors made at this point could be very costly. Nonetheless, the estimated cost savings of this approach gained the support of all parties.

The estimated savings with the EAB approach are \$200 million or 20% savings on the total spares buy (1). Table V shows the estimated savings by associate contractor projected for fiscal years 1985, 1986, and 1987. These estimates were provided by each contractor. The basis of these estimates are through participation in SAIP, large material buy discounts, and efficient production runs. It is highlighted that additional savings could be added to these totals if problems such as set up costs were included. It is noted that one associate contractor predicted cost growth on some items of over 500% (1) due to small and discontinuous production runs if normal initial provisioning techniques were followed.

To implement this acquisition strategy, each associate hosted a provisioning conference to identify EAB/MYP candidates. Out of all the total investment in spares that must be provisioned to support the B-1B, 75% of Rockwell's, 97% of Boeing's, and 85% of AIL's were identified. This activity concluded 15 October 1983. This initial activity was considered a success since a large percentage of items could be obtained with the EAB approach. The remaining items would require normal initial provisioning techniques.

TABLE V
SAIP EAB Savings/Cost Avoidance
(TY \$ in millions)

	FY84	FY85	FY86	FY87	TOTAL
Rockwell					
Normal ¹	37.5	100.4	199.4	58.1	394.9
EAB	29.6	80.3	159.5	46.5	315.9
Savings	7.4	20.1	39.9	11.6	79.0
Boeing					
Normal	53.5	115.1	134.4	50.1	353.1
EAB	42.8	92.1	107.5	40.1	282.5
Savings	10.7	23.0	26.9	10.0	70.6
AIL					
Normal	65.5	143.8	156.0	35.2	400.5
EAB	60.9	133.7	145.1	32.7	372.4
Savings	4.6	10.1	10.9	2.5	28.1
General Electric					
Normal	5.7	68.0	85.1	85.7	244.5
EAB	5.0	59.2	74.0	74.6	212.8
Savings	.7	8.8	11.1	11.1	31.7

[3]

1. Normal business means using normal initial provisioning techniques and replenishment buys.

The groundrules were to acquire enough spares to support 99 aircraft over four years. Effectively, this requirement fills all logistics pipelines with sufficient quantities of parts to support the entire fleet of B-1Bs over its life, except for out-year condemnation requirements.

In November 1983, the Air Force sought incremental funding approval. OSD approved of the EAB concept in December 1983 with Congressional approval coming in January 1984. Termination liability requirements of the government were negotiated as follows:

Termination Liability (\$ in millions)

Rockwell	224.6
Boeing	266.7
AIL	267.8 [3]

Oklahoma City ALC provisioning personnel are currently refining supply support requirements now that all EAB items have been identified. This task is very difficult because of the large quantity of items. Once the requirements are identified, orders will be placed with the associate contractors. It is imperative that the maintenance factors and other logistics data used to quantify the spares' buy are as accurate as possible since all B-1B spares requirements (on those items going through EAB) are being satisfied. A mistake here could be costly.

Another activity taking place is that procedures for handling engineering change orders are being established. The point here is to insure that only those changes that are really needed are approved, since many spares will be or are already on order. A major activity in a program office is managing changes. The Air Force has been accused of "gold plating" or of

enforcing unrealistic requirements, which increases the probability of change. Once MYP has been approved, the Air Force must resist future changes, i.e. must be satisfied with the item's current physical and performance characteristics. However, when a major program such as the B-1B program is approved and directed to have production proceed prior to the completion of testing (concurrency), the probability of needed change increases. A MYP decision shifts additional risks on the Air Force. Any changes that are made will result in much higher retrofit costs than would be if normal initial provisioning techniques were employed.

As shown, the savings are high, but so are the risks when considering the termination liability requirements and the chance of acquiring inaccurate quantities of spares. A high level of communication and cooperation is necessary to insure a successful result.

III. MYP Simulation Model

Problem Description

The purpose of this model is to evaluate the cost impacts that would result from making a MYP decision versus an annual year decision on an item. The intent of the model is not to account for all costs, but to key on the major cost drivers that would impact this decision. The analysis, by displaying resulting impacts, will help the decision maker decide on the appropriate strategy to implement. As discussed in Chapter 1, the key cost elements are:

1. spares
2. engineering changes
3. transportation
4. storage
5. administration

This model accounts for these cost elements. Another piece of information that impacts these cost elements is the delivery schedule of the weapon system itself. For example, a program that has a stretched-out delivery schedule could delay the acquisition of spares, and the spending profile of a MYP strategy would be quite different from an annual year strategy. On the other hand, a compacted delivery schedule will require early delivery of assets regardless of the acquisition strategy, i.e., the cost profile differences between the two strategies would be minimized.

Additionally, the item characteristics will impact the expenditure profiles. An unreliable item could favor a MYP decision due the upfront savings, i.e., many spares must be acquired to support the weapon system and a MYP decision lowers acquisition price. Of course if the item is not design stable, the savings will be negated with the costs associated with engineering changes. A very reliable item would minimize any MYP savings because the quantity of assets required would also be minimized.

The sources of information needed and resulting impacts are shown in Figure 2.

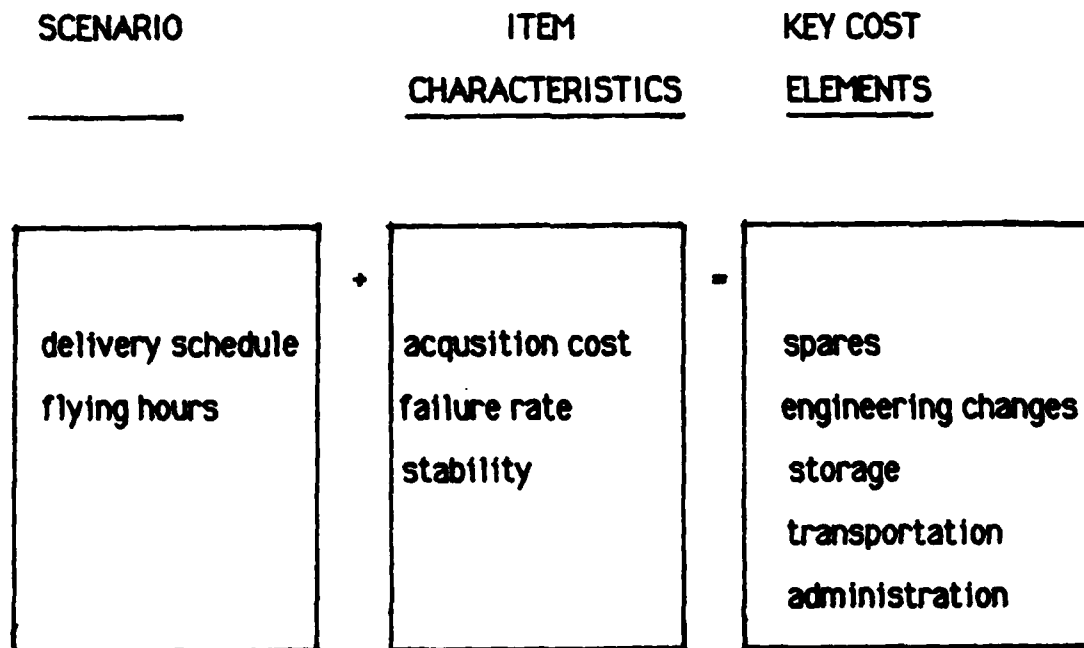


Figure 2. Decision Determinants

The interactions between these elements are very complex and both the scenario and the item characteristics are subject to change, especially on a new weapon system. Additionally, all types of items with varying characteristics are contained in a weapon system and one acquisition strategy is not optimal in all situations.

The simulation technique was chosen due to the complexity of this decision process. A simulation model is a representation of reality. The MYP simulation model developed in this thesis simulates the logistics environment of a part, estimates the required spares needed to support that item over time, and then estimates the expected key costs that would result from a MYP versus an annual year acquisition decision. A major benefit of a representation model is that data elements can be varied (sensitivity analysis) to evaluate expected impacts. This feature is especially desirable on new programs where little or no historical information is available. The benefit is to let the decision maker aware of all potential impacts of his decision making.

Program Description

The MYP simulation model is written in the SIMSCRIPT II.5 programming language. SIMSCRIPT is a high order, general purpose programming language developed by the RAND corporation. SIMSCRIPT uses near-English terminology which makes programming and debugging large problems relatively easy. The manual, SIMSCRIPT II.5 Programming Language, written by Kiviat, Villanueva, and Markowitz is the basis for the MYP simulation model (27). The simulation program is currently hosted on the AFLC CREATE computer system located at Wright-Patterson Air Force Base. Flow charts that illustrate the program logic are located in Appendix-B. For those interested, the SIMSCRIPT computer code is located in Appendix-C.

The first step in the model is to initialize all data elements, arrays,

subroutines, and events. The data elements are presented and defined in the next section. After initialization and the data are read, the program events are scheduled. Events are where activities are performed in the simulation and they control the passage of time. Table VI is a listing of the events and subroutines in the model. The first event, deployment, allocates the aircraft to the bases. The key event that controls program operation is event sortie. Time is advanced in the model as each aircraft is scheduled and completes a sortie. The entire time period of this simulation is four years which is the support period for the B-1B MYP program. After an aircraft is deployed, its first sortie is scheduled. From then on, another sortie is scheduled after each sortie is completed. When a sortie is completed, the aircraft is inspected for any failures. Every item being evaluated has a probability of failure calculated based upon its failure rate and the sortie length. Each item is individually checked. If an item has failed, the model determines the location of repair (intermediate or depot), checks for an available spare, and schedules when the failed item will be available again after maintenance. There is also a check made to confirm that repairs were successful, since it is possible that the item could be condemned (thrown away). Items with high condemnation rates require addition spares to account for the items failing repair. The location of repair is important since additional assets will be required if repair is to be accomplished at a depot because of the longer pipeline time involved. The spare check routines determine the quantity of spares that will be required to support the system at any moment in time. The spares costs for the annual option is based on the annual price and the inflation index (i.e. the current time in the simulation). The MYP spares cost is based upon the MYP price.

TABLE VI
List of Events and Subroutines

<u>Events</u>	<u>Purpose</u>
Main	Read data and program initialization
Deployment	Deploy aircraft to bases
Sortie	Accumulate time
	Check for failures
	Schedule spares checks
	Schedule repairs
	Schedule next inspection
LRU Repair	Check for successful repair
SRU Repair	Check for successful repair
ECP	Determine annual year ECP costs
Multiyear	Tabulate multiyear statistics
Report	Print reports
Termination	Stop simulation
<u>Subroutines</u>	
LRU spare check	Check inventory
	Acquire spares as required
SRU spare check	Check inventory
	Acquire spares as required

Engineering change activity is simulated by periodically initiating ECPs into the model. This activity is controlled by the input data as will be shown in the next section. When an ECP occurs, the costs are tabulated and is based on the current quantity of spares and the ECP cost itself. For the MYP option, ECP costs are based on the total quantity of spares acquired at the end of the simulation versus the current requirement for the annual option.

Administration costs are those expenses that are based on implementing contracts. For the MYP option, this is a one time cost, since one contract will cover all requirements. For the annual year option, this expense is determined by how many contracts are issued. In this evaluation it is assumed that requirements are acquired to cover the current year's requirement, so this expense is determined by the number of years that new assets were acquired.

Storage costs are calculated based on how many assets are on hand. This costs is lower for the annual year option since the buy is spread-out over a longer period of time.

Transportation costs are those costs that are incurred when an ECP is scheduled. The expense is determined by the number of assets, the number of ECPs, and the shipping expense.

Model Input

The following data definitions are used in this simulation:

1. Inflation factors - appropriate inflation index to be applied against the spares acquisition price.

2. Delivery schedule - deliveries by month.
3. Base deployment schedule - basing plan
4. LRU name - nomenclature
5. LRU MTBD - mean time between demand
6. NRTS - not repair this station
7. Number of SRUs - contained inside a LRU
8. LRU cost - annual year price (first year)
9. Condemnation rate - % not repaired when failure occurs
10. QPA - quantity per aircraft
11. MYP price - price assuming a MYP contract
12. ECP - price of an average ECP
13. ECP profile - number of ECPs per year for a particular part
14. SRU name - nomenclature
15. LRU indenture - relates SRU to a LRU
16. SRU MTBD - mean time between demand
17. SRU cost - annual year price
18. Condemnation rate - % not repaired when failure occurs
19. MYP price - price assuming a MYP contract
20. ECP cost - ECP price
21. ECP profile - number of ECPs per year

Model Output

The output of the model with a sample input file is displayed in Appendix-A. As shown, the input data is echoed back to the user and resulting calculations are displayed in tabular form. Further explanations and interpretations of the output are contained in Chapter IV.

IV. Analysis

Data

The purpose of this thesis was to evaluate whether MYP is a cost-effective approach for acquiring spares. In order to accomplish this objective, the first step was to develop a methodology that can be used to evaluate the economics and risks associated with implementing MYP on a spares buy. The simulation modeling technique was chosen and now an example application will be demonstrated. In choosing the simulation technique, a primary task was to determine and acquire the necessary information requirements. This was accomplished by decomposing the spares costs into those elements (cost drivers) that will result in different costs depending on the contract option (i.e. MYP or annual year contract) implemented. The five areas determined to be the cost drivers are shown with their respective data requirements in Table VII.

Table VIII shows the baseline data used in the evaluation. These data are estimates provided by the SPO and were obtained by questioning responsible Air Force managers. While these data are subject to change and debate, they do provide a baseline to start with in order to determine the cost drivers of a MYP decision. Once the drivers are established, sensitivity analysis can be performed on any element to determine the impacts.

The item data are shown in Table IX. These data are obtained from contractual provisioning reports from the contractor (2). The predicted MTBD data source is Boeing. The MTBD data labeled as D220 represents the Air Force estimate of the item's reliability. D220 is the label given the provisioning system used by the Air Force.

TABLE VII
Data Requirements

Elements	Data Needs	Source
1. Spares Costs	MYP Price	SPO
	Annual Price	SPO
	Operating Requirements	SPO
	Spares Requirements¹	computed
	Requirement Profile	computed
	Maintenance Factor	SPO
	Quantity per Application	SPO
	NRTS Rate	SPO
	Aircraft Delivery Schedule	SPO
	Inflation Factors	SPO
2. ECP Costs	Spares Requirements	computed
	ECP Costs	SPO
	Number of ECPs	SPO
3. Transportation	Spares Requirements	computed
	Number of ECPs	SPO
	Shipping Costs	SPO
4. Storage	Spares Requirements	computed
	Storage Costs	SPO
5. Administration	Number of Buys	computed
	Administration Costs	SPO

¹Spares requirements = f(operating hours, delivery profile, item characteristics)

TABLE VIII
Baseline Data

ECP Costs: 10% of acquisition price.

Computer Control Avionics - \$16147.
Station Logic Unit - \$24315.
Power Supply C&D - \$2058.
Electronic Display Unit - \$6894.
Radar Signal Processor - \$116791.
Radar Video Processor - \$33917
Jettison Control - \$616.
Indicator, Multifunction Display - \$2027.

ECP Frequency: 1 per year.

Administration Costs: \$1000. per buy.

Shipping Costs:

LRU - \$30. per event.
SRU¹ - \$10. per event.

Storage Costs:

LRU - \$100. per year per unit.
SRU¹ - \$15. per year per unit.

Inflation Rate Factors: 5% per year after year 2.

1st year - 1.0
2nd year - 1.0
3rd year - 1.05
4th year - 1.10
5th year - 1.16

¹Only LRUs are evaluated in this study.

TABLE IX

Item Characteristics

Item Name Part Number	QPA	EST Price	D220 Price	Pred MTBD (hours)	D220 MTBD (hours)	NRTS
Computer Control 400-10021-31	8	\$161471.	\$255753.	852	135	5%
Station Logic Unit 400-10096-101	1	\$243153.	\$422000.	2538	1540	5%
Power Supply C&D 400-10075-101	3	\$20580.	\$38600.	1401	1176	5%
Display Electronics 400-10014-4	2	\$68947.	\$85000.	608	236	5%
Radar Signal Proc 400-11678-6	2	\$1167914.	\$1095555.	115	115	5%
Radar Video Proc 400-11678-9	1	\$339172.		279	279	5%
Jettison Control 400-10072-101	1	\$6165.		33333	125000	5%
Indicator, MFD 400-11213-1 [2]	3	\$20274.	\$31063.	608	145	17%

Findings

The results are presented by answering each of the research questions proposed in Chapter 1.

Research Question One. What are the cost drivers associated with a MYP strategy? Figure 3 illustrates the differences of the total costs and the cost elements between the MYP and annual year options as computed for the computer control avionics unit. As the chart shows, the two major cost drivers are potential spares savings and ECP risks with the MYP option. Figure 4 illustrates a similar result for the radar signal processor (RSP) unit. The implications are that while transportation, storage, and administration costs are impacted, they are insignificant when compared to the total costs and need not be considered when assessing contracting options. These elements should be viewed only as "other considerations" when deciding on the appropriate option to employ. Even if the baseline data is inaccurate, these elements cannot be considered cost drivers. However, spares costs and ECP costs are very significant and are the two costs drivers regarding the contracting decision. The remainder of this thesis concentrates on these two elements.

Table X shows the results from the the MYP simulation model on all of the selected items evaluated in this thesis. As shown, the MYP decision is slightly favored on all items except the jettison control. These calculations are using the baseline data previously presented. The results indicate an "indifferent" preference regarding the appropriate strategy to employ, but the two cost drivers are clearly evident (acquisition costs and ECP costs).

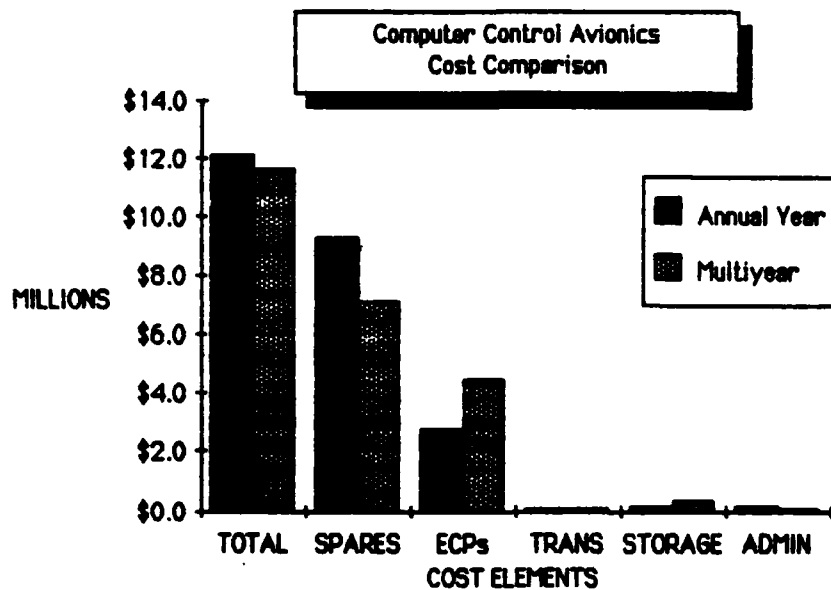


Figure 3. Computer Cost Elements

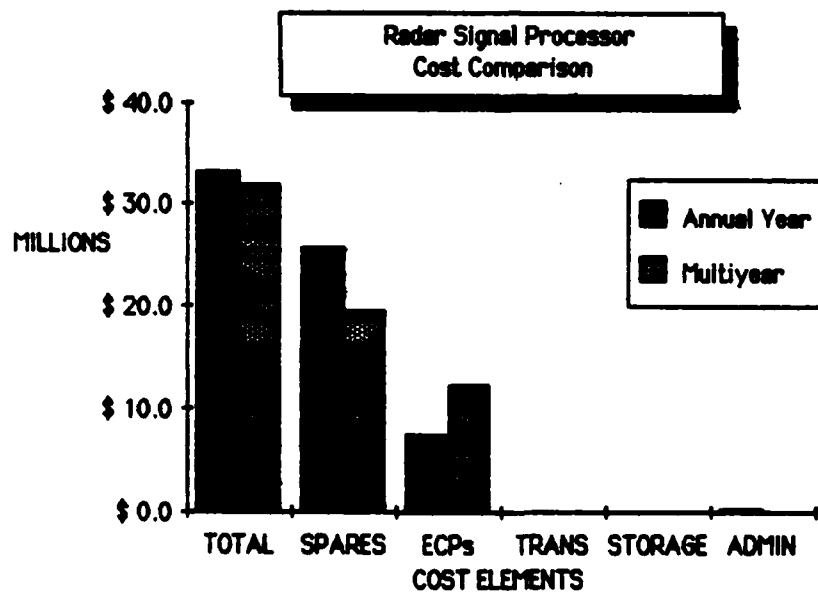


Figure 4. Radar Cost Elements

TABLE X
Cost Comparison
(\$ in millions)

	Spares	ECPs	Trans	Storage	Adm	Total
Computer Control Avionics						
Annual	9.3007	2.729	.005	.0169	.004	12.0556
MYP	7.1047	4.44	.008	.0275	.001	11.5812
Station Logic Unit						
Annual	1.3009	.3161	.0004	.0013	.003	1.6217
MYP	.9726	.608	.0008	.0025	.0025	1.5864
Power Supply C&D						
Annual	.1286	.039	.0006	.0019	.003	.1731
MYP	.0988	.062	.0009	.003	.001	.1657
Electronics Display Unit						
Annual	.9377	.2827	.001	.0041	.004	1.2295
MYP	.717	.4481	.002	.0065	.001	1.1746
Radar Signal Processor						
Annual	25.8109	7.3579	.002	.0063	.004	33.1811
MYP	19.6210	12.2631	.003	.0105	.001	31.898
Radar Video Processor						
Annual	2.7982	.9158	.0008	.0027	.003	3.7205
MYP	2.1707	1.3767	.0012	.004	.001	3.5536
Jettison Control						
Annual	.0068	.0013	.00005	.0002	.001	.0094
MYP	.0049	.0031	.00015	.0005	.001	.0096
Multifunction Display						
Annual	.8312	.2172	.0035	.0117	.004	1.0676
MYP	.6325	.2953	.006	.0195	.001	.9543

NOTE: Item characteristics assume predicted costs, D220 MTBD, 20% savings on MYP 1st year acquisition price, and other baseline data.

Research Question Two. What are the impacts due to the item's spares requirement? The quantity of spares and the delivery profile necessary to support the end item (i.e. weapon system) drives all of the cost elements as shown previously in Table VII. These two factors (spares requirements and delivery profile) impacts whether or not spares acquisition can be delayed and for how long this delay can occur. The B-1B delivery schedule is relatively compact for a major weapon system. All B-1B deliveries are scheduled to be complete within a three year period of time. This is partly due to the relatively small number of B-1Bs (99) when compared to other major weapon systems such as the F-16.

Figure 5 illustrates the spares buildup profile required for the computer control avionics under various maintenance factor (MTBD) assumptions as output from the MYP simulation model. As shown, the requirements are needed early and the total spares requirements build quite rapidly as the reliability prediction becomes increasingly pessimistic (lower MTBD). There are eight computer control avionics units onboard each aircraft, which also accounts for the large quantity of spares required.

Figure 6 illustrates the spares buildup and total requirements for the RSP. While there are only two RSPs onboard each aircraft, a similar result is shown (i.e early spares buildup and quantity affected by the MTBD estimate). These two charts show that while the spares buy can be delayed, the fast pace of the B-1B program requires early delivery of assets regardless of the contracting option chosen. This result would favor a MYP decision since buys must be completed early. On the other hand, the computed potential savings would be less on the B-1B program than another program with a stretched-out delivery schedule, since the out-year impacts are minimized on the B-1B program assuming minimal engineering changes.

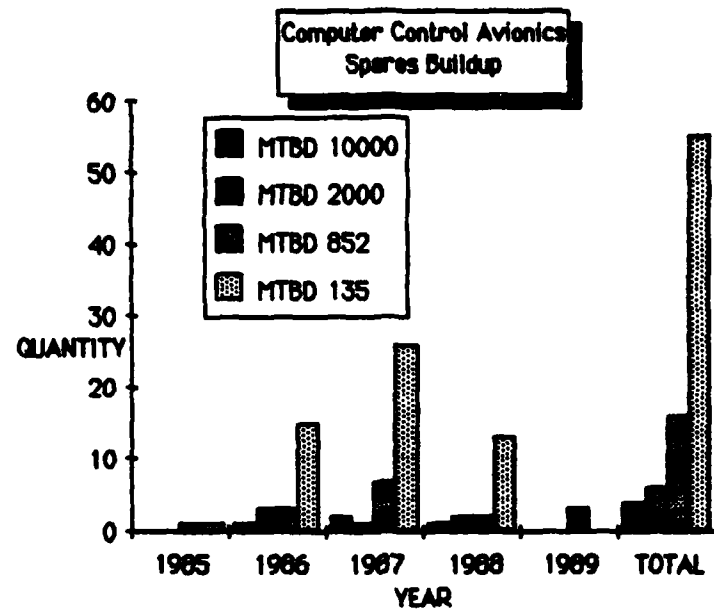


Figure 5. Spares Buildup for Computer

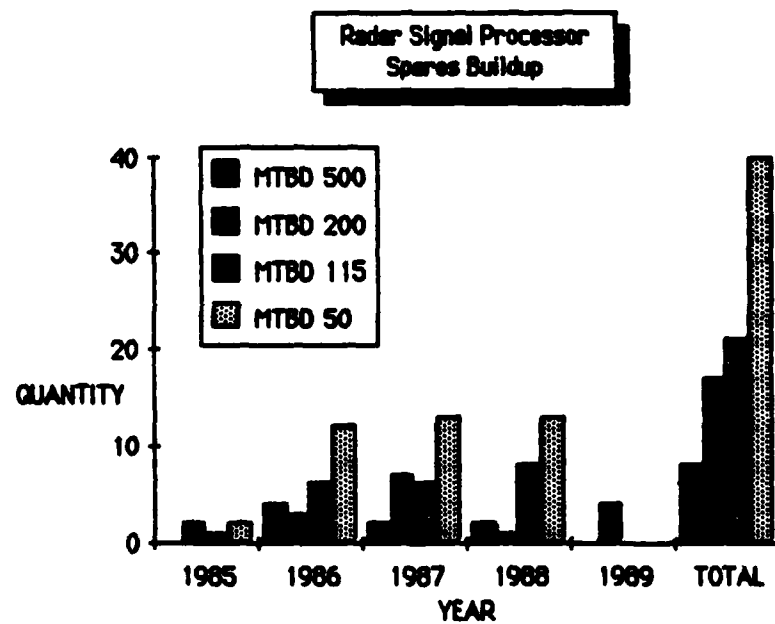


Figure 6. Spares Buildup for the Radar

Research Question Three. What are the impacts of engineering changes? The risk of ECPs has been evaluated as being one of the cost drivers of a MYP decision for spares. The baseline evaluation used the following data for the initial computation:

- a. ECP cost per unit - 10% of annual year acquisition cost.
- b. Number of ECPs - 1 per year.

These data are estimates obtained from discussions with responsible managers at the SPO to use in lieu of "better" information. Historical data on ECPs are difficult to find and utilize. Most items on a new weapon system are usually unique, in at least some respects, making exact comparisons difficult. If the items are essentially common, then it would be safe to assume minimal or no changes and the MYP decision would be appropriate because of the limited risk involved. Research that has looked into ECP trends has shown tremendous variance across different weapon system programs. An AFIT thesis research by Good evaluated ECP trends on DOD programs and concluded this independency among weapon system programs (12:66). This research implies that data obtained from one program on even similar items would be of no value in predicting ECP occurrence on the B-1B.

For this reason, a sensitivity analysis on both the number of ECPs and the cost of ECPs, will at least provide the decision-maker information regarding the criticality and potential impacts of ECPs on an item being considered to be contracted for with the MYP approach. This analysis can then be supplemented with "expert opinion" from the responsible engineers. The assumption is that the responsible engineer is the most knowledgeable (i.e. best source of information) regarding both the design stability of an item and the degree of change required (i.e. potential costs), if an item is

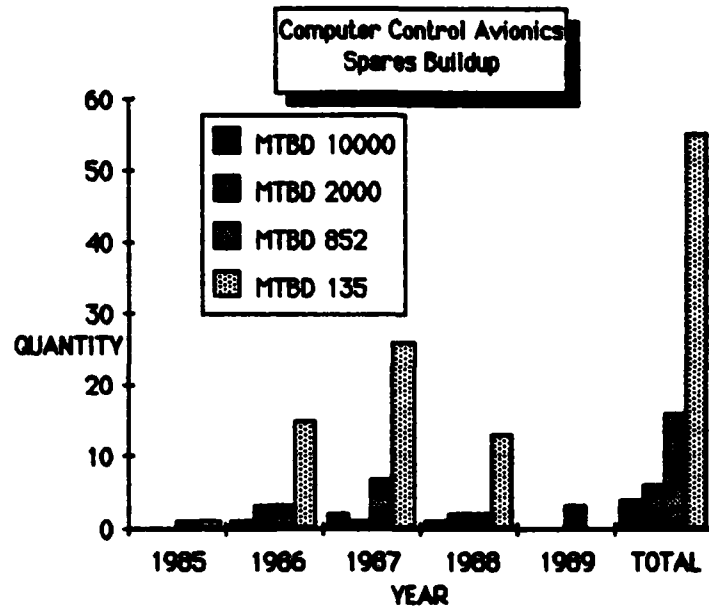


Figure 5. Spares Buildup for Computer

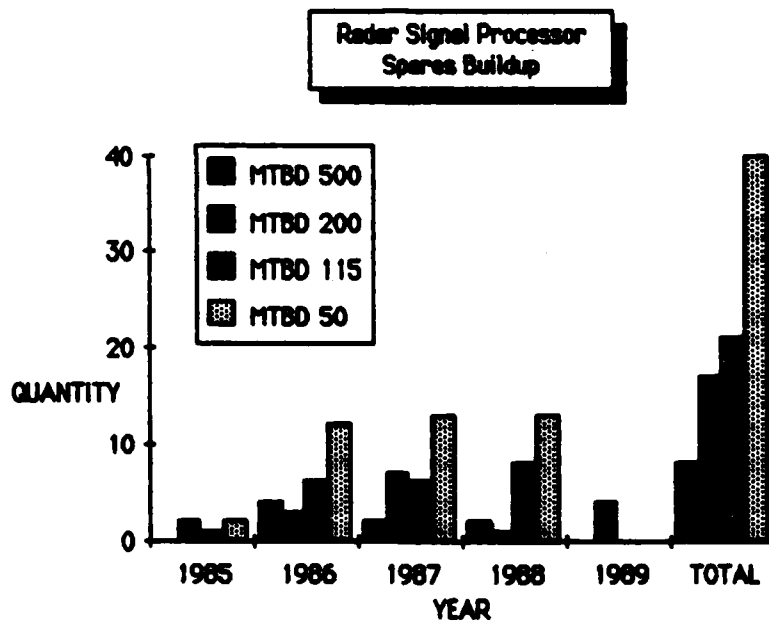


Figure 6. Spares Buildup for the Radar

not yet design stable. Figure 7 illustrates the sensitivity analysis on the computer control avionics. First, notice that the breakeven point (point where the decision-maker would be indifferent between a MYP or an annual year approach) regarding the number of ECPs is approximately 1.3 ECPs per item per year. Figure 8 illustrates a similar relationship for the radar signal processor. In fact, all items regardless of its physical and performance characteristics have this same potential breakeven point. This breakeven point can also be shown to be equivalent to two ECPs per year if one estimates the cost of an ECP to be 5% of the annual unit acquisition cost. Table XI displays exact values for each item. Now these parameters can be matched against "expert opinion" from the responsible engineers on the design stability of each item. It is important to note that the breakeven points are only valid for use on these B-1B items. Another weapon system program with a different delivery schedule and operating scenario would exhibit different conclusions regarding the breakeven point. This points out the benefit of the MYP simulation model, since these potential differences can be easily computed.

Engineering Assessment. An engineering assessment on the design stability of each item was made by the B-1B SPO engineering directorate (14). Now that the potential economic benefits and risks are quantified regarding engineering changes, the design stability evaluation becomes a key element determining MYP success.

According to the B-1B engineering office, all items except for the two radar items are design stable. They state that several changes are anticipated on the radar components as flight testing continues. The concurrency between production and test is a major factor regarding the

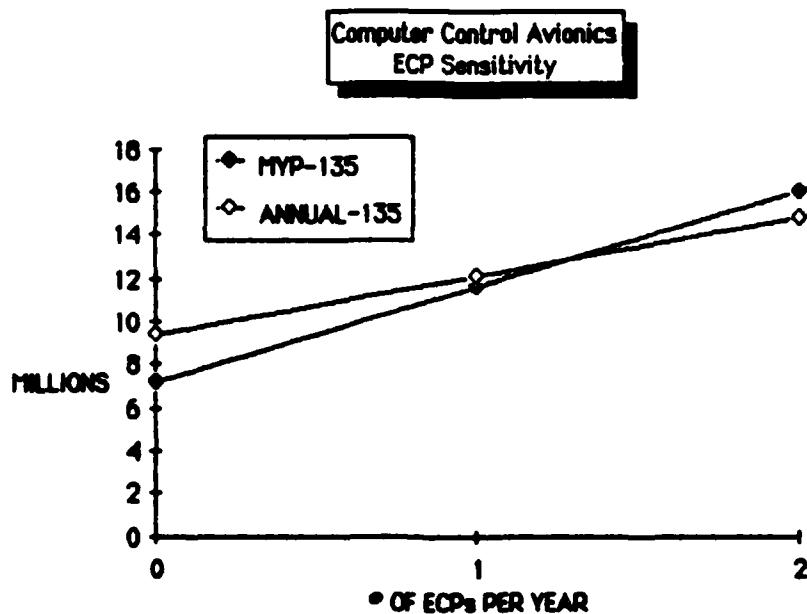


Figure 7. ECP Sensitivity - Computer

TABLE XI

ECP Sensitivity (\$ in millions)

# of ECPs	0	1	2
Computer Cnt	2.1821	.4705	-1.241
Station Logic	.3282	.036	- .2553
Power Supply	.0301	.007	- .0152
Display Elec	.2197	.054	- .1112
Radar Processor	6.1861	1.2809	-3.6243
Radar Video	.6274	.1865	- .2545
Control Jettison	.0014	- .00045	- .0023
MFD	.189	.03	- .127

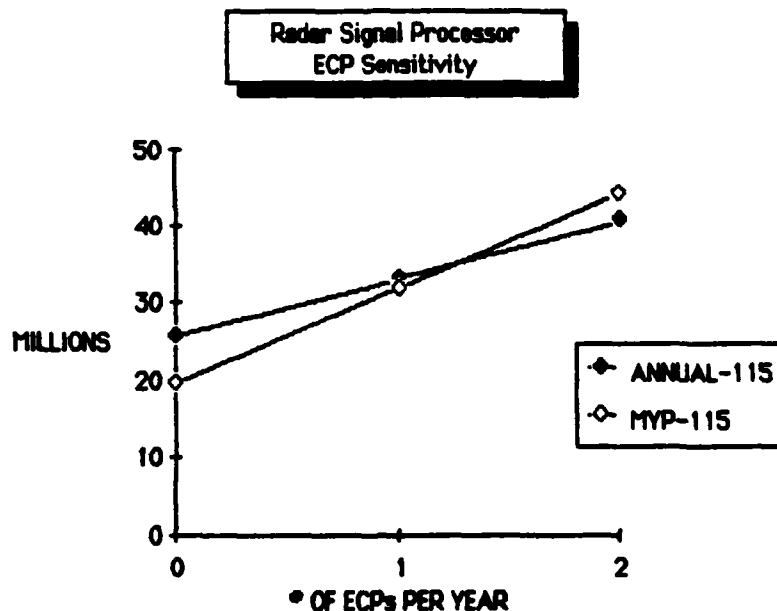


Figure 8. ECP Sensitivity - Radar

potential changes on the radar. The B-1B SPO configuration office stated that no ECPs are in process on any of the selected items at this time. Therefore, it can be concluded that MYP is an appropriate contracting technique to employ on all items evaluated except for the two radar items.

Research Question Four. What are the impacts due to quantity adjustments? A potential risk of MYP is the impact regarding acquiring the wrong quantity of spares. When the contracting method is annual contracting, this problem does not exist since quantities are adjusted each year. However this can be a significant problem when employing MYP. This problem is especially evident on the B-1B program since the delivery schedule is compact. The MYP buy on the B-1B program is essentially acquiring enough spares to fill all maintenance pipelines. This problem is two-fold. If the MYP buy is too small, then some potential benefits are lost. On the other hand, if the buy is too large, then an unnecessary expenditure of

funds has occurred.

The key elements impacting the spares buy has already been discussed. The three key elements are:

1. Operating scenario.
2. Maintenance plan.
3. Item failure rate.

The item's failure rate is the most uncertain, especially on newly developed items. The exact failure rate to base the spare's buy will never be known when needed. Since an overbuy is nonrecoverable, the prudent manager should be conservative in the MYP buy, even though potential savings may be lost. The best technique to account for the this problem is to quantify the required assets assuming various failure rate estimates and evaluate the potential risk. The risk of overbuy is not a major problem on high reliability items, but is a major risk on low reliability/high cost items. Table XII displays the needed quantity of assets as computed from the MYP simulation model for the selected items with a sensitivity analysis. The percentages indicate an increase or decrease in the reliability estimate.

As shown in Table XII, a pessimistic estimate of the failure rate (MTBD estimate used for provisioning is too low), will result in a large overbuy of spares. This is especially evident on the computer control, where the baseline MTBD equates to a requirement of 55 spares. However, if the true MTBD is 50% better, than the required quantity of spares equates to only 45 units, an overbuy of 10 units. This problem is not as severe on higher reliability items such as the power supply. Nonetheless, the sensitivity analysis provides the decision maker with a quantified analysis of this potential problem.

TABLE XII

Spare Requirements

Item	Baseline	+50%	+100%	-50%	-100%
Computer Cnt	55	45	32	70	103
Station Logic	5	2	2	5	6
Power Supply	6	4	4	9	11
Display Electronics	13	12	7	16	24
Radar Processor	21	18	13	28	39
Radar Video	8	7	5	12	12
MFD	39	29	20	47	66

Research Question Five. What are the Inflation Impacts? As discussed in the literature review on MYP, inflation avoidance is a major cost savings area and reason to implement a MYP contract. High inflation was prevalent a few years ago, but inflation has declined recently. This research has assumed an inflation rate of five percent per year, which is considered a moderate rate. The findings indicated that MYP was appropriate for all of the selected items as long as the number of ECPs does not surpass one per year. If the true inflation rate is higher than five percent, then it can be concluded that additional savings would be attained from the MYP implementation. However, if the true inflation rate is lower, then MYP savings will diminish. Therefore an important sensitivity analysis is computing the expected savings assuming a zero inflation rate, i.e. all savings are from lower pricing due to economic material purchases. Table XIII shows the results of this analysis. The results show that savings

TABLE XIII

MYP Cost Savings (\$ in millions)

0% Inflation Rate

# of ECPs	0	1	2
Computer Cnt	1.7893	.14705	-1.5046
Station Logic	.2431	-.04865	-.3404
Power Supply	.0251	.0045	-.0161
Display Elec	.1784	.01295	-.1525
Radar Processor	4.6687	.34745	-3.9738
Radar Video	.4749	.03395	-.407
Control Jettison	.0007	-.00115	-.003
MFD	.1384	.00465	-.1291

levels are decreased as compared to Table XI, but only two decisions would change. The control jettison unit and the station logic unit would now favor an annual decision assuming one ECP per year. These items are both very reliable and MYP advantages were small due to the small spares requirements for these items. Therefore it can be concluded that while inflation avoidance is an important element, the MYP decision should reside from the unit pricing advantages and not be based on inflation avoidance which is a very difficult figure to estimate. However, the inflation impact needs to be quantified since it is considered a major element that justifies MYP implementation.

Research Question Six. How sensitive are the acquisition savings levels? This research assumed an upfront savings level of 20% based on the

expected annual price, independent of inflation. The use of 20% is based on SPO and B-1B contractor estimates. According to history, the 20% figure is achievable, but is on the high side. The MYP literature review indicated savings levels from 1% to 25% depending on the computation technique and other assumptions. The low figures used discounting while the high figures represent raw savings. A sensitivity analysis on this element will help a decision maker by showing impacts assuming the expected savings are not achieved. Table XIV shows the results of a sensitivity analysis showing impacts, assuming acquisition savings at various levels, while holding all other assumptions constant.

TABLE XIV

Achieved Savings Level (\$ in millions)

% MYP Savings	0%	5%	10%	20%	25%
Logic	-.1661	-.0718	-.0108	.0373	.0859
Power	-.0201	-.0156	-.0040	.0075	.0146
Elec Display	-.1228	-.1160	-.0292	.0464	.1013
Computer	-1.4904	-.9068	-.0357	.5114	2.4283
Radar Proc	-3.4349	-2.5479	-.7605	1.3656	2.7526
Radar Video	-.3330	-.2193	-.1528	.1684	.2586
Cnt Jettison	-.0010	-.0009	-.0010	-.0004	-.0005
MFD	-.0967	-.0716	-.0269	.0396	.0794

As shown from Table XIV, additional risks are shifted toward the government as the upfront savings level decreases. Also shown, is that savings are not achieved until a saving level greater than 10% is achieved. Of course, this computation is assuming the baseline data (i.e. one ECP per year). One interesting observation is that the control jettison unit does not show savings even at a level of 25%. This is due to the low cost and associated low potential for savings on this unit. The analysis does show that the government should strive for acquisition savings levels greater than 10%, or the potential ECP risks will become too great.

Research Question Seven. Are some types of items better suited for MYP than others? There are many factors impacting the MYP application. This research has shown that the same factors that lend support to the MYP decision can also be risk factors on a MYP decision. Table XV summarizes these factors.

TABLE XV		
MYP Decision Elements		
	MYP Benefit	MYP Risk
Price Level-Unit Prices		
High	Large Savings	Large ECP Costs
Low	Small Savings	Small ECP Costs
Failure Rate-Impacts Spares Quantities		
High	Large Savings	Large ECP Costs
Low	Small Savings	Small ECP Costs
Inflation Rate-Impacts upfront Savings		
Operating Scenario-Impacts Spares Quantities		

An appropriate MYP decision depends on the interaction of all of these factors. While an item may be evaluated to be design stable, unless the potential for savings are high enough, a MYP decision may not be appropriate. For example, the item may be so reliable that future maintenance demands will be far downstream and a possibility exists that changes could happen which will make the item useless. The bottom line is that all factors must be considered in order to make the appropriate MYP decision.

V. Conclusion

This thesis has developed the downstream risk potential and a methodology for evaluating the risk of implementing a MYP decision for spares to support a weapon system. Five elements were determined to be potential risk factors that need consideration in any MYP decision for spares acquisition. The elements are spares costs, ECP costs, transportation costs, storage costs, and administration costs. However, only acquisition savings (material savings due to larger buys) compared to the potential ECP costs were determined to be cost drivers. Accordingly, these two elements should be given intense evaluation before any MYP approval. The other elements should not be ignored, but be evaluated as 'other considerations' in the decision process.

The methodology used for this thesis is simulation modeling. Simulation was used due to the complexity of the problem and to insure all interactions are considered. A MYP decision can not be treated as a steady-state problem that most models of this sort assume. As presented, the program scenario, (i.e. delivery schedule, flying hour profile, etc.) must not be ignored. With use, further model updates can be easily added if addition factors become relevant. In addition, the model can be easily adjusted to simulate other weapon system MYP considerations.

This thesis concentrated on the B-1B spares MYP contract. Of the eight items evaluated from the B-1B program, five items were determined as "good" MYP candidates, from an economic point of view. The two radar components were determined to be risky MYP items because of the potential for additional design changes. The one control unit was determined to be a

marginal MYP item because of the limited savings potential of this item. The key parameters that were determined for the B-1B program in regards to ECPs, were that as long as only one or fewer ECPs per year are approved, the MYP decision will be economically sound. In addition, the minimum acquisition savings need to exceed 10% over the expected annual year price. Inflation needs consideration, but should not be a major determinant in the decision process due to variation in this element. Of course, the program needs stability in terms of force size to minimize buying inaccurate requirements. Finally, related to ECP potential, the items should be stable enough to insure requirements can be accurately determined. The question regarding stability will be always present on a new program and the MYP decision should not be disapproved just because something is new. The savings potential is present, but so are the risks. The purpose of the MYP simulation model is to allow for the evaluation of these risks. The question remains on whether the B-1B MYP spares buy will be successful. On the whole, at least looking at the small sample in this thesis, the overall result will most likely be favorable. However, certain items approved for MYP should have used traditional contracting methods, such as the radar due to the potential for change. Other weapon systems can value from the model developed in this thesis from both an evaluation and a negotiation standpoint by having a quantified estimate of the potential risk from implementing the MYP contracts.

As developed, the characteristics that allow for high levels of savings, can also be the characteristics that cause the high levels of risk. In other words, high cost items (i.e. high upfront savings potential) are often associated with high technology (i.e. high potential for ECPs). Therefore it is important to evaluate each item individually for each

application. Three key factors (program scenario, acquisition cost, design stability) all play together. It is important to restate that the conclusions reached in this thesis regarding stability requirements and savings levels are only valid on the B-1B program. Another weapon system that varies in the number of systems, the flying hour profile, etc. could very well reach other conclusions. The F-16 program is very different from the B-1B program. A larger program with a stretched-out delivery schedule could be taking on even larger risks than the B-1B program, depending on the time period covered by the MYP contract. This is where the benefit of the MYP simulation model resides. By having a model available that can quantify the savings and risks, a program manager can be in a position to better evaluate and justify his decision making.

Additional research is still needed in this area. The recommendations are:

1. ECP frequencies and costs. Additional research in this area could be beneficial if a data base could be developed that would help predict the ECP potential of a new item. Engineering judgement can not be replaced, but such a data base would help an analyst develop initial data estimates for MYP studies.

2. Future B-1B evaluation. It would be quite worthy if data is continuously collected on the B-1B program for MYP evaluation purposes. This analysis was completed before operational experience was obtained. The collection of data would benefit both the attainment of item's economic, reliability and design stability characteristics and the attainment of other contract considerations that could influence the MYP simulation model.

3. Implement model on future programs. If the model was to be used

on a future program, additional model refinement could be obtained. The point is to both influence the MYP decision process on a new program and to fine tune the MYP simulation with additional experience.

Appendix - A

Model Input and Output

The following input file and output illustrates the operation of the MYP simulation model. The example is using data collected on the computer avionics control unit. A sensitivity analysis on the failure rate is shown and the resulting cost differences are a result of the failure rate variability. All data is displayed in the output except for transportation times, administration costs, storage costs and shipping costs which can be changed internally in the model. The values used are shown in Chapter IV, Table 4-2.

Input File Example

Explanation

Aug 1985 ----- Current Date
B-1B -----Program
29.5 5.1----- Flying hours per Month / Sortie Length
1985 5 5-----Year Start / Report / Quit
1.0 1.0 1.05 1.10 1.15----- Inflation Factors
0 0 0 0 0 1 0 1 0 1 1-----Delivery Schedule Year 1
1 2 1 2 2 2 3 3 4 4 4 4----- Year 2
4 4 4 4 4 4 4 4 4 4 4 4----- Year 3
4 4 4 3 0 0 0 0 0 0 0 0----- Year 4
4-----Number of Bases
29-----Base 1
34-----Base 2
18-----Base 3
18-----Base 4
3-----Number of LRUs
COMP-1 10000 .05 0 161471. 0 8 129176. 161147. 1 1 1 1 1-Item Data
COMP-2 852 .05 0 161471. 0 8 129176. 161147. 1 1 1 1 1-Item Data
COMP-3 135 .05 0 161471. 0 8 129176. 161147. 1 1 1 1 1-Item Data

Example Output

Aug 1985

Inflation Factors

1	2	3	4	5
1.00	1.00	1.05	1.10	1.15

B-1B Delivery Schedule

YR	J	F	M	A	M	J	J	A	S	O	N	D	
85	0	0	0	0	0	0	1	0	1	0	1	1	4
86	1	2	1	2	2	2	3	3	4	4	4	4	32
87	4	4	4	4	4	4	4	4	4	4	4	4	48
88	4	4	4	3	0	0	0	0	0	0	0	0	15
													Total = 99

Base Deployment Schedule

Base # # of Aircraft

1	29
2	34
3	18
4	18

LRU Reliability and Maintainability Data

								ECP	
	FAIL	NRTS	# OF	ANNUAL	COND	QPA	MYP	ECP	PROFILE
	RATE	RATE	SRUS	PRICE	RATE		PRICE	COST	1 2 3 4 5
COMP-1	10000	.05	0	161471.	0.	8	129176.	16147.	1 1 1 1 1
COMP-2	852	.05	0	161471.	0.	8	129176.	16147.	1 1 1 1 1
COMP-3	135	.05	0	161471.	0.	8	129176.	16147.	1 1 1 1 1

End Of Year Status Report

1990

.0975 Million Flying Hours

.1072 Million Operating Hours

19497 Sorties Completed

LRU Removal Data

6941 LRUs Removed Distributed Among the 3 LRUs Thus

85 952 5904

Final Cost Breakdown For Comp-1

	Annual	MYP
LRU Spares -	\$.6782	\$.5167
SRU Spares -	\$ 0.	\$ 0.
LRU ECP Costs -	\$.1938	\$.3230
SRU ECP Costs -	\$ 0.	\$ 0.
Transportation -	\$.0004	\$.0006
Storage -	\$.0012	\$.0020
Administration -	\$.0030	\$.0010
	<hr/>	<hr/>
Total Costs -	\$.8766	\$.8433

Spares Buildup By Year

Year	1	2	3	4	5	Total
	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
	0	1	2	1	0	4

Final Cost Breakdown For Comp-2

	Annual	MYP
LRU Spares -	\$ 2.7499	\$ 2.0668
SRU Spares -	\$ 0.	\$ 0.
LRU ECP Costs -	\$.7266	1.2918
SRU ECP Costs -	\$ 0.	\$ 0.
Transportation -	\$.0014	\$.0024
Storage -	\$.0045	\$.0080
Administration -	\$.0050	\$.0010
	<hr/>	<hr/>
Total Costs -	\$ 3.4874	\$ 3.3700

Spares Buildup By Year

Year	1	2	3	4	5	Total
	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
	1	3	7	2	3	16
	<hr/>					

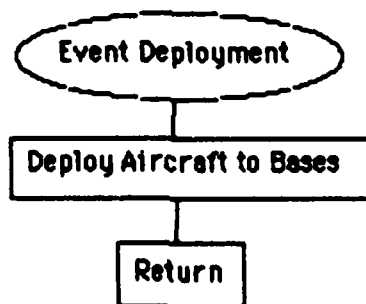
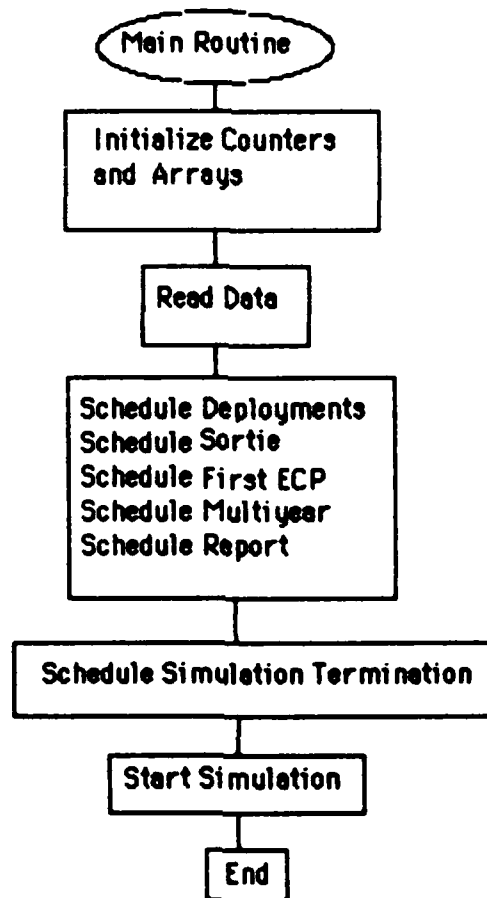
Final Cost Breakdown For Comp-3

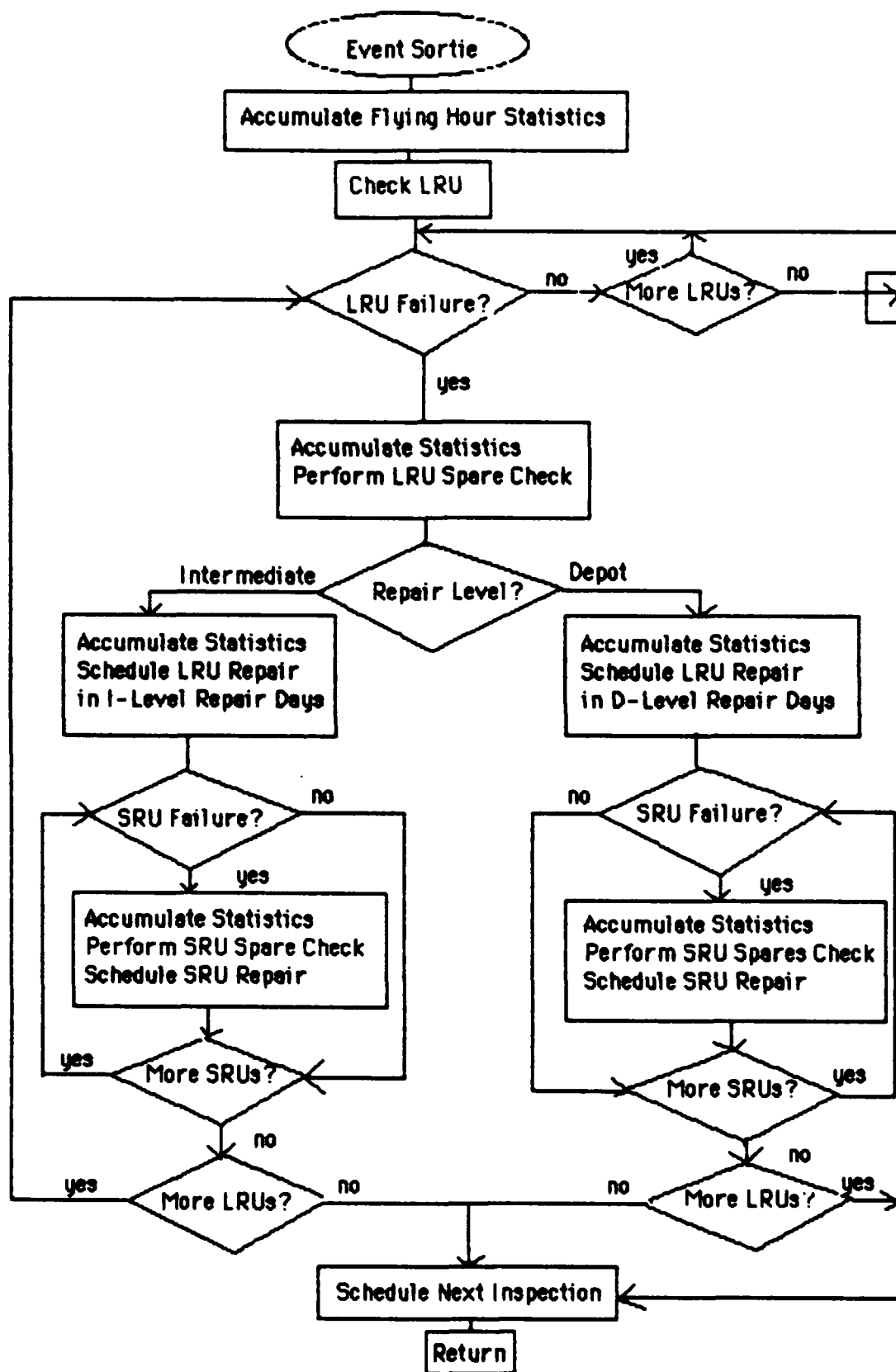
	Annual	MYP
LRU Spares -	\$9.3007	\$ 7.1047
SRU Spares -	\$ 0.	\$ 0.
LRU ECP Costs -	\$ 2.729	\$ 4.4400
SRU ECP Costs -	\$ 0.	\$ 0.
Transportation -	\$.005	\$.008
Storage -	\$.0169	\$.0275
Administration -	\$.0040	\$.0010
	<hr/>	<hr/>
Total Cost -	\$12.0556	\$11.5812

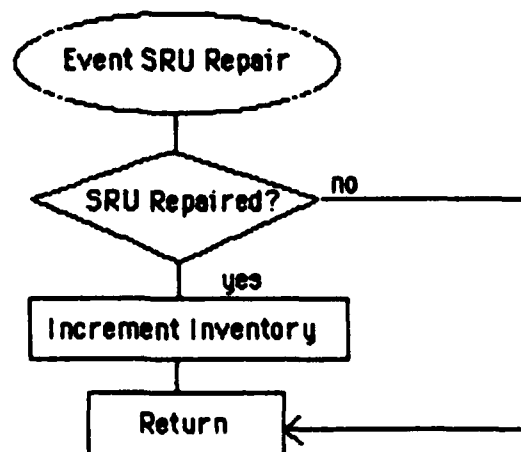
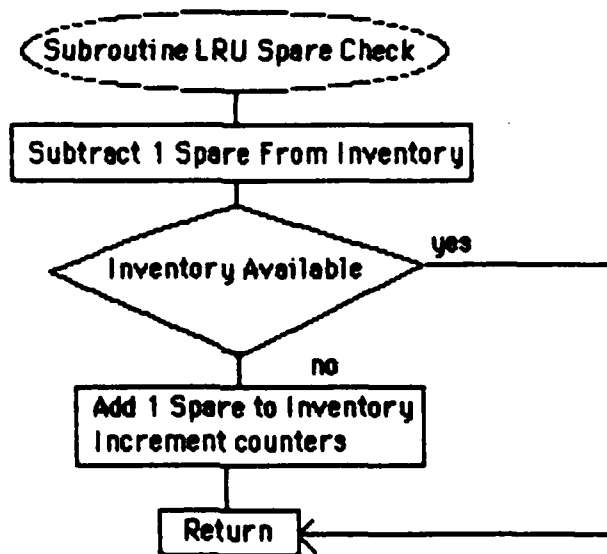
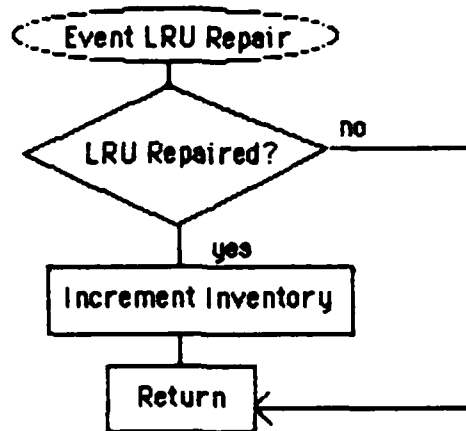
Spares Buildup By Year

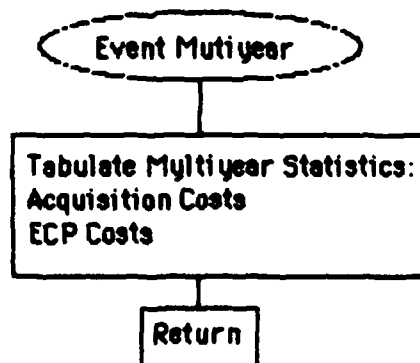
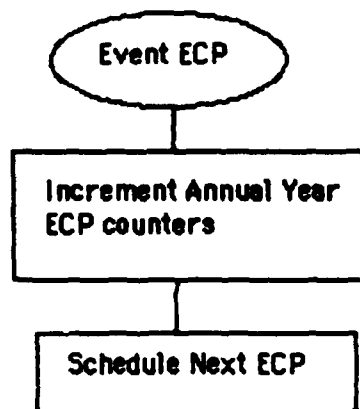
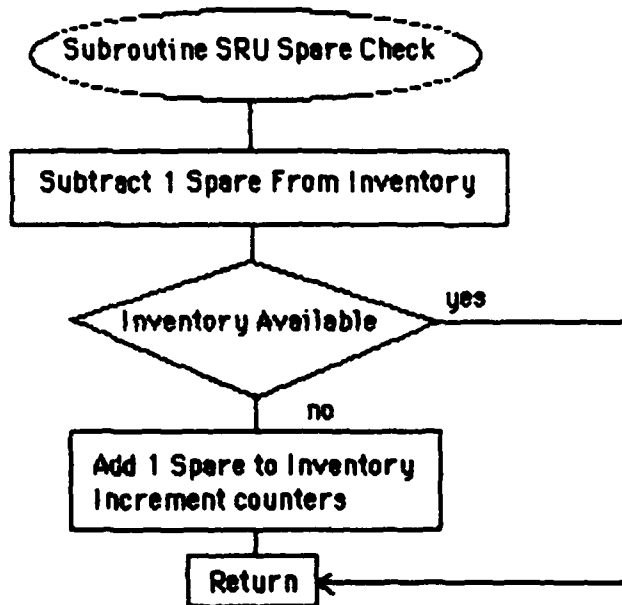
Year	1	2	3	4	5	Total
	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
	1	15	26	13	0	55

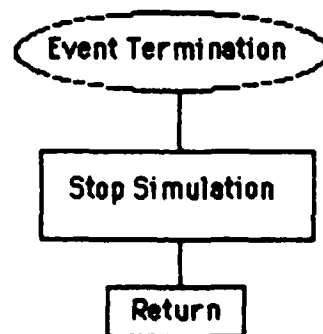
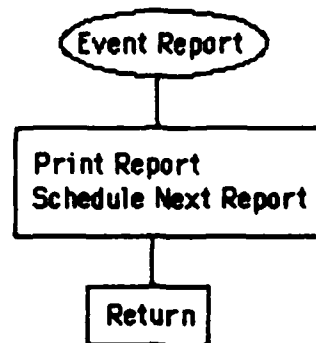
Appendix - B
Program Flowcharts











Appendix - C. Program Listing

The following pages are a listing of the SIMSCRIPT programming code for the MYP simulation model. SIMSCRIPT code uses near-English phases which makes understanding the code and program flow very easy. Appendix-B provides program flowcharts that will facilitate an understanding of the program operation for those interested. SIMSCRIPT II.5 Programming Language manual, March 1973, by Consolidated Analysis Centners INC. and edited by E. C. Russell, provides complete explanations for all detailed SIMSCRIPT features and is the basis for this simulation program.

```
0010**S,J
0020$ IDENT WP1598,ASD-BILR BODNAR MYP
0030$ LIMITS 15,40K,,10K
0040$ LOWLOAD
0050$ OPTION FORTRAN,NOMAP
0060$ LIBRARY SL
0070$ PROGRAM RLHS
0080$ LIMITS 15,40K,,10K
0090$ PRMFL H*,R,R,CACI/SIM2.5
0100$ FILE *1
0110$ FILE *2
0120$ FILE B*,B1S
0130 PREAMBLE
0140 NORMALLY MODE IS INTEGER
0150 EVENT NOTICES INCLUDE
0160 DEPLOYMENT,
0170 INSPECTION,
0180 MULTI,
0190 ECP,
0200 ADMIN,
0210 REPORT,
```

```

0220  END.OF.YRSTATS
0230  EVERY LRUREPAIR HAS A PART
0240  EVERY SRUREPAIR HAS A A AND A C
0250  DEFINE LRUCHECK AS A ROUTINE WITH 1 VALUE
0260  DEFINE SRUCHECK AS A ROUTINE WITH 2 VALUES
0270  DEFINE B,PLANES,ICOUNT,LCNT,REMLRU,
0280      ILRU,DLRU,INT.HRS,DEP.HRS,MAX,E.TOT AS VARIABLES
0290  DEFINE YR.START,YR.REPORT,YR.QUIT,NO.OF.BASES AS VARIABLES
0300  DEFINE YR.COUNT AS A VARIABLE
0310  DEFINE MIL AS A VARIABLE
0320  DEFINE ORATE,IRATE,DRATE,ICOST,DCOST,
0330      SORTIE,FHP,TBS,FHT,OPT  AS REAL VARIABLES
0340  DEFINE BASEQTY,SE.RQMT,LREM,SCNT,LRU,SLRU,PQ,
0350      SREM,NLRU,LQPA,ADM AS 1-DIMENSIONAL ARRAYS
0360  DEFINE ANECP,AN.SRU,MY.ECP,MYSRU,TLCOST,TSCOST,TRANS,TRMY,
0370      CSMY,CMY,STOR,STMY AS 1-DIMENSIONAL REAL ARRAYS
0380  DEFINE NSECP AS A 3-DIMENSIONAL ARRAY
0390  DEFINE REMSRU,SRU,NSRU,SSRU,NLECP,YRLRU AS 2-DIMENSIONAL
    ARRAYS
0400  DEFINE SRUPROB,SCOND,SCOST,CSECP,SMYP
0410  AS 2-DIMENSIONAL REAL ARRAYS
0420  DEFINE SE.COST,LCOST,NRTS,LCOND,LRUPROB,CLECP,MYP,
0430      INFLA AS 1-DIMENSIONAL REAL ARRAYS
0440  DEFINE PRGM AS AN ALPHA VARIABLE
0450  DEFINE NAME AS A 2-DIMENSIONAL ALPHA ARRAY
0460  END
0470  MAIN
0480  RESERVE SRUPROB,REMSRU,NSRU,SRU,SSRU,NLECP,SCOST,
0490      CSECP,SMYP,SCOND,YRLRU AS 5 BY 100
0500  RESERVE LRUPROB,CLECP,LREM,NRTS,SCNT,LRU,SLRU,LCOST,
0510      LCOND,SREM,MYP,INFLA AS 30
0520  RESERVE ANECP,AN.SRU,MY.ECP,MYSRU,TLCOST,TSCOST,TRANS,TRMY,
0530      CSMY,CMY,STOR,STMY AS 30
0540  RESERVE NSECP AS 5 BY 100 BY 5
0550  RESERVE NLRU,LQPA,ADM AS 30
0560  RESERVE PQ AS 132
0570  RESE.PVE BASEQTY AS 30
0580  RESERVE SE.COST,SE.RQMT AS 3
0590  DEFINE SNAME AS A 1-DIMENSIONAL ALPHA ARRAY
0600  RESERVE NAME AS 30 BY 2

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0610  RESERVE SNAME AS 2
0620  DEFINE DATE AS A 1-DIMENSIONAL ALPHA ARRAY
0630    RESERVE DATE AS 2
0640  LET MIL = 1000000
0650  READ DATE(1),DATE(2) WRITE DATE(1),DATE(2) AS B 60,2 A 5,/
0660  " READ SE.COST(1),SE.COST(2),SE.COST(3)
0670  READ PRGM
0680  READ FHP, SORTIE, ORATE, IRATE, DRATE
0690  READ YR.START, YR.REPORT, YR.QUIT
0700  FOR I = 1 TO YR.QUIT READ INFLA(I)
0710  SKIP 2 LINES PRINT 2 LINES THUS
0720      INFLATION FACTORS
0730      1      2      3      4      5
0740  FOR I = 1 TO YR.QUIT WRITE INFLA(I) AS
0750      S 5,D(4,2)
0760  READ MAX FOR I = 1 TO MAX READ PQ(I)
0770  LET YR.COUNT = 1
0780  SKIP 3 LINES PRINT 2 LINES WITH PRGM THUS
0790      ***** DELIVERY SCHEDULE
0800  YR J F M A M J J A S O N D
0810  LET CY = YR.START LET J = 1
0820  FOR K = 1 TO ((MAX + 11) / 12) DO
0830  WRITE CY AS I 4 LET JJ = J + 11
0840  FOR I = J TO JJ ADD PQ(I) TO TOT
0850  FOR I = J TO JJ WRITE PQ(I) AS (12) I 4
0860  WRITE TOT AS B 52, I 4, / ADD TOT TO TOTAL
0870      LET TOT = 0
0880  LET CY = CY + 1 LET J = J + 12
0890  LOOP
0900  WRITE TOTAL AS B 46, "TOTAL =", I 4, /
0910  " -----
0920  READ NO.OF.BASES FOR I = 1 TO NO.OF.BASES READ BASEQTY(I)
0930  SKIP 1 LINE PRINT 2 LINES THUS
0940      BASE DEPLOYMENT SCHEDULE
0950  BASE * * OF A/C
0960      FOR I = 1 TO NO.OF.BASES WRITE I, BASEQTY(I) AS
0970          I 6, I 10, /
0980      FOR I = 2 TO NO.OF.BASES LET BASEQTY(I) = BASEQTY(I) +
          BASEQTY(I-1)
0990  LET B = 1 LET SE.RQMT(1) = 1 LET SE.RQMT(2) = 1

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1000  "- - - - - SCHEDULE INSPECTIONS
1010  FOR I = 1 TO MAX DO
1020    IF PQ(I) = 0 JUMP AHEAD ELSE
1030    LET PDAYS = 30.42 / PQ(I)
1040    FOR J = 1 TO PQ(I) SCHEDULE AN INSPECTION IN
1050      (PDAYS * J) + (30.42 * (I - 1)) + ((SORTIE / FHP)
1060        * 30.42) DAYS
1070    FOR J = 1 TO PQ(I)
1080      SCHEDULE A DEPLOYMENT IN (PDAYS * J) + 30.42 * (I - 1) DAYS
1090    HERE LOOP
1100    START NEW PAGE PRINT 4 LINES THUS
1110      LRU RELIABILITY AND MAINTAINABILITY DATA
1120      ECP
1130      FAIL NRTS * OF ANNUAL COND QPA MYP ECP PROFILE
1140      RATE RATE SRUS PRICE RATE PRICE COST 1 2 3 4 5
1150    READ LCNT FOR I = 1 TO LCNT DO
1160    READ NAME(I,1),NAME(I,2),LRU(I),NRTS(I),SCNT(I),LCOST(I),LCOND(I),
1170    LQPA(I),MYP(I),CLECP(I),NLECP(I,1),NLECP(I,2),NLECP(I,3),
1180    NLECP(I,4),
1190    NLECP(I,5)
1200    WRITE I,NAME(I,1),NAME(I,2),LRU(I),NRTS(I),SCNT(I),LCOST(I),
1210    LCOND(I),LQPA(I),MYP(I),CLECP(I),NLECP(I,1),NLECP(I,2),
1220    NLECP(I,3),NLECP(I,4),NLECP(I,5)
1230    AS 1 2,2 A 6,1 6,S 1,D(4,2),S 1,1 4,S 1,D(8,0),S 3,D(4,2),S 1,1 3,
1240    D(8,0),D(7,0),S 1 2,/
1250    LET LRUPROB(I) = SORTIE / LRU(I) * LQPA(I)
1260    LOOP
1270  "START NEW PAGE PRINT 2 LINES THUS
1280  "      LRU FAIL ANNUAL COND MYP ECP ECP PROFILE
1290  "      IDENT RATE PRICE RATE PRICE COST 1 2 3 4 5
1300  FOR I = 1 TO LCNT DO
1310  FOR J = 1 TO SCNT(I) DO
1320  READ SNAME(1),SNAME(2),SRU(I,J),SCOST(I,J),SCOND(I,J),SMYP(I,J),
1330  CSECP(I,J),NSECP(I,J,1),NSECP(I,J,2),NSECP(I,J,3),NSECP(I,J,4),
1340  NSECP(I,J,5)
1350  WRITE J,SNAME(1),SNAME(2),I,SRU(I,J), SCOST(I,J),
1360  SCOND(I,J),SMYP(I,J),
1370  CSECP(I,J),NSECP(I,J,1),NSECP(I,J,2),NSECP(I,J,3),NSECP(I,J,4),
1380  NSECP(I,J,5)
1390  AS 1 2,S 2,2 A 6,S 2,1 4,S 3,1 5,S 2,D(8,0),S 2,D(4,2),

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1380  D(8,0),D(6,0),5 I 2,/
1390  LET SRUPROB(I,J) = LRU(I) / SRU(I,J)
1400    LOOP
1410      LOOP
1420  LET TBS = ((30.42 * 24) / (FHP / SORTIE) / 24)
1430  SCHEDULE A ECP IN 365 DAYS
1440  SCHEDULE A MULTI IN 365 * YR.QUIT DAYS
1450  SCHEDULE A ADMIN IN 365 * YR.QUIT DAYS
1460  SCHEDULE A REPORT IN 365 * YR.REPORT DAYS
1470  SCHEDULE A END.OF.YRSTATS IN 366 * YR.QUIT DAYS
1480  CALL ORIGIN.R(1,1,YR.START)
1490  START SIMULATION
1500  END
1510  "
1520  " *****
1530  EVENT DEPLOYMENT
1540  ADD 1 TO PLANES
1550  IF PLANES > BASEQTY (B) ADD 1 TO SE.RQMT (1) ADD 1 TO SE.RQMT (2)
1560    ADD 1 TO B
1570  ALWAYS RETURN  END
1580  "
1590  " *****
1600  EVENT INSPECTION
1610  ADD 1 TO ICOUNT  ADD SORTIE TO FHT  ADD SORTIE*1.1 TO OPT
1620    FOR I = 1 TO LCNT  DO
1630  IF RANDOM.F(9) < LRUPROB(I) GO TO 'REMOVE.LRU' ELSE  JUMP AHEAD
1640  'REMOVE.LRU'
1650  ADD 1 TO LREM(I)  ADD 5 TO INT.HRS  ADD 1 TO REMLRU
1660  PERFORM LRUCHECK(I)
1670  IF RANDOM.F(5) < NRTS(I) GO TO 'DEPOT.REPAIR' ELSE
1680    GO TO 'IREPAIR'
1690  'IREPAIR'
1700  SCHEDULE AN LRUREPAIR(I) IN 4 DAYS
1710  ADD 1 TO ILRU
1720  ADD 4 TO INT.HRS
1730  FOR J = 1 TO SCNT(I) DO
1740    IF RANDOM.F(8) < SRUPROB(I,J)
1750      ADD 1 TO SREM(I)
1760      ADD 1 TO REMSRU(I,J)
1770      ADD 10 TO DEP.HRS

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1780     PERFORM SRUCHECK(I,J)
1790 "     ADD 10 TO TRANS(I)
1800     SCHEDULE AN SRUREPAIR(I,J) IN 54 DAYS
1810 ALWAYS LOOP
1820     JUMP AHEAD
1830 'DEPOT.REPAIR'
1840     SCHEDULE AN LRUREPAIR(I) IN 50 DAYS
1850     ADD 1 TO DLRU
1860     ADD 4 TO DEP.HRS
1870 "     ADD 30 TO TRANS(I)
1880     FOR J = 1 TO SCNT(I) DO
1890     IF RANDOM.F(8) < SRUPROB(I,J)
1900         ADD 1 TO SREM(I)
1910         ADD 1 TO REMSRU(I,J)
1920         ADD 10 TO DEP.HRS
1930         PERFORM SRUCHECK(I,J)
1940         SCHEDULE AN SRUREPAIR(I,J) IN 40 DAYS
1950 ALWAYS LOOP
1960     HERE LOOP
1970     SCHEDULE AN INSPECTION IN TBS DAYS
1980     RETURN END
1990 "
2000 " *****
2010 SUBROUTINE LRUCHECK(NUM)
2020     SUBTRACT 1 FROM NLRU(NUM)
2030     IF NLRU(NUM) < 0 ADD 1 TO SLRU(NUM) ADD 1 TO NLRU(NUM)
2040     ADD LCOST(NUM) * INFLA(YR.COUNT) TO TLCOST(NUM)
2050     ADD 1 TO YRLRU(YR.COUNT,NUM)
2060     ALWAYS RETURN END
2070 "
2080 " *****
2090 EVENT LRUREPAIR(PART)
2100     IF RANDOM.F(1) > LCOND(PART) ADD 1 TO NLRU(PART)
2110     ALWAYS RETURN END
2120 "
2130 " *****

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2140  SUBROUTINE SRUCHECK(I,J)
2150    SUBTRACT 1 FROM NSRU(I,J)
2160    IF NSRU(I,J) < 0 ADD 1 TO SSRU(I,J) ADD 1 TO NSRU(I,J)
2170    ADD SCOST(I,J) * INFLA(YR.COUNT) TO TSCOST(I)
2180    ALWAYS RETURN END
2190  "
2200  " *****
2210  EVENT SRUREPAIR(A,C)
2220    IF RANDOM.F(1) > SCOND(A,C) ADD 1 TO NSRU(A,C)
2230  ALWAYS RETURN END
2240  "
2250  " *****
2260  EVENT REPORT
2270    START NEW PAGE DEFINE TOT.COST AS A REAL VARIABLE
2280    DEFINE TOT.MYP AS A REAL VARIABLE
2290    DEFINE SE1,SE2 AS REAL VARIABLES
2300    ADD YR.REPORT TO YR.START
2310    SKIP 1 LINE PRINT 3 LINES WITH YR.START + 1900  THUS
2320      END OF YEAR STATUS REPORT
2330      *****
2340      -----
2350    SKIP 2 LINES
2360    PRINT 2 LINES WITH FHT/MIL, OPT/MIL, ICOUNT  THUS
2370    ***** MIL. FLYING HOURS ***** MIL. OPERATING
HOURS
2380    ***** SORTIES COMPLETED
2390    SKIP 1 LINE PRINT 3 LINES WITH REMLRU,LCNT  THUS
2400    -----
2410      LRU REMOVAL DATA
2420    ***** LRUS REMOVED DISTRIBUTED AMONG THE ***  THUS
2430    FOR I = 1 TO LCNT WRITE LREM(I) AS 1 7
2440  "SKIP 1 LINE PRINT 3 LINES WITH ILRU,DLRU  THUS
2450  "      LRU REPAIR ACTIVITY
2460  "    ***** LRUS REPAIRED AT INTERMEDIATE LEVEL
2470  "    ***** LRUS REPAIRED AT DEPOT LEVEL
2480  "    SKIP 1 LINE PRINT 2 LINES  THUS
2490  "    -----
2500  "      SRU REMOVAL DATA
2510  "FOR I = 1 TO LCNT DO
2520  "    PRINT 1 LINE WITH I,SREM(I)  THUS

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2530 "LRU NUMBER *** HAD ***** FAILURES DISTRIBUTED THUS
2540 " FOR J = 1 TO SCNT(I) WRITE REMSRU(I,J) AS 1 5 ,/
2550 " LOOP
2560 "SKIP 1 LINE PRINT 2 LINES THUS
2570 " -----
2580 "          LRU SPARES REQUIREMENT
2590 " FOR I = 1 TO LCNT WRITE SLRU(I) AS 1 5
2600 "   SKIP 1 LINE PRINT 2 LINES      THUS
2610 " -----
2620 "          SRU SPARES REQUIREMENT
2630 " FOR I = 1 TO LCNT DO
2640 "   SKIP 1 LINE PRINT 1 LINE WITH I THUS
2650 "   LRU NUMBER *** SPARES
2660 "   FOR J = 1 TO SCNT(I) WRITE SSRU(I,J) AS 1 5
2670 "   LOOP
2680 "   LET ICOST = INT.HRS * 25.00 / MIL
2690 "   LET DCOST = DEP.HRS * 50.00 / MIL
2700 "   LET SE1=SE.COST(1) * SE.RQMT(1)
2710 "   LET SE2=SE.COST(2) * SE.RQMT(2)
2720 "   SKIP 2 LINES PRINT 7 LINES WITH INT.HRS, DEP.HRS, SE.RQMT(1),
2730 "   SE.RQMT(2)      THUS
2740 " -----
2750 "          MAINTENANCE AND SUPPORT EQUIPMENT
2760 "   I-LEVEL MANHOURS = *****
2770 "   D-LEVEL MANHOURS = *****
2780 "   O-LEVEL S.E. RQMT = *****
2790 "   I-LEVEL S.E. RQMT = *****
2800 "   D-LEVEL S.E. RQMT = 1
2810 "   LET TOT.SE = SE1 + SE2 + SE.COST(3)
2820 "   FOR I = 1 TO LCNT DO
2830 "   LET TOT.COST = (TRANS(I) / MIL) + (ANECPI(I) / MIL) + (AN.SRU(I) /
MIL) +
2840 "   (STOR(I) / MIL)+(TLCOST(I) / MIL)+(TSCOST(I) / MIL)+(ADM(I) /
MIL)
2850 "   LET TOT.MYP = (TRMY(I) / MIL ) + (CMY(I) / MIL ) + (CSMY(I) / MIL ) +
2860 "   (STMY(I) / MIL)+(MY.ECPI(I) / MIL)+(MYSRU(I) / MIL)+(1000 / MIL)
2870 "   SKIP 1 LINE PRINT 12 LINES WITH NAME(I,1),NAME(I,2),
2880 "   TLCOST(I) / MIL, CMY(I) / MIL,
2890 "   TSCOST(I) / MIL, CSMY(I) / MIL, ANECPI(I) / MIL, MY.ECPI(I) / MIL,
2900 "   AN.SRU(I) / MIL, MYSRU(I) / MIL,

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2910 TRANS(1) / MIL, TRMY(1) / MIL, STOR(1) / MIL, STMY(1) / MIL,
2920 ADM(1) / MIL, 1000 / MIL, TOT.COST, TOT.MYP  THUS
2930 -----
2940             FINAL COST BREAKDOWN FOR  *****
2950             ANNUAL             MYP
2960             LRU SPARES  = $***** ***** $*****
2970             SRU SPARES  = $***** ***** $*****
2980             LRU ECP COST = $***** ***** $*****
2990             SRU ECP COST = $***** ***** $*****
3000             TRANSPORTATION = $***** ***** $*****
3010             STORAGE     = $***** ***** $*****
3020             ADMINISTRATION = $***** ***** $*****
3030 -----
3040             TOTAL COST   = $***** ***** $*****
3050             SKIP 2 LINES PRINT 5 LINES WITH
              YRLRU(1,1),YRLRU(2,1),YRLRU(3,1),
3060             YRLRU(4,1),YRLRU(5,1),SLRU(1)  THUS
3070             SPARES BUILDUP BY YEAR
3080             YEAR      1      2      3      4      5      TOTAL
3090             -----
3100             *****  *****  *****  *****  *****  *****
3110 -----
3120             HERE  LOOP
3130             SCHEDULE A REPORT IN 365 * YR.REPORT DAYS
3140             RETURN  END
3150 " *****
3160             EVENT ECP
3170             FOR I = 1 TO LCNT DO
3180             ADD SLRU(I) * NLECP(I,YR.COUNT) * CLECP(I) TO ANECP(I)
3190             ADD SLRU(I) * NLECP(I,YR.COUNT) * 30 TO TRANS(I)
3200             ADD SLRU(I) * 100 TO STOR(I)
3210             FOR J = 1 TO SCNT(I) DO
3220             ADD SSRU(I,J) * NSECP(I,J,YR.COUNT) * CSECP(I,J) TO AN.SRU(I)
3230             ADD SSRU(I,J) * NSECP(I,J,YR.COUNT) * 10 TO TRANS(I)
3240             ADD SSRU(I,J) * 15 TO STOR(I)
3250             LOOP
3260             LOOP
3270             ADD 1 TO YR.COUNT
3280             SCHEDULE A ECP IN 365 DAYS
3290             RETURN  END

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3300 " *****
3310  EVENT MULTI
      3320  LET E.TOT = 0
3330  LET MYSRU(I) = 0.0
3340  LET MY.ECP(I) = 0.0
3350  FOR I = 1 TO LCNT DO
3360    ADD SLRU(I) * MYP(I) TO CMY(I)
3370  FOR M = 1 TO 5 DO
3380    ADD NLECP(I,M) TO E.TOT
3390  LOOP
3400  LET TRMY(I) = E.TOT * SLRU(I) * 30
3410  ADD SLRU(I) * 100 * YR.QUIT TO STMY(I)
3420  LET MY.ECP(I) = E.TOT * CLECP(I) * SLRU(I)
3430  LET E.TOT = 0
3440    FOR J = 1 TO SCNT(I) DO
3450      ADD SSRU(I,J) * SMYP(I,J) TO CSMY(I)
3460    FOR M = 1 TO 5 DO
3470      ADD NSECP(I,J,M) TO E.TOT
3480    LOOP
3490  ADD E.TOT * SSRU(I,J) * 10 TO TRMY(I)
3500  ADD SSRU(I,J) * 15 * YR.QUIT TO STMY(I)
3510  LET MYSRU(I) = E.TOT * CSECP(I,J) * SSRU(I,J)
3520  LET E.TOT = 0
3530  LOOP
3540    LOOP
3550  RETURN  END
3560 " *****
3570  EVENT ADMIN
3580  FOR I = 1 TO LCNT DO
3590  FOR J = 1 TO YR.QUIT DO
3600    IF YRLRU(J,I) > 0 ADD 1000 TO ADM(I)
3610    ALWAYS LOOP
3620  LOOP
3630  RETURN  END
3640 " *****
3650  EVENT END.OF.YRSTATS
3660  STOP  END
3670$  SOURCE
3680$  EXECUTE
3690$  LIMITS 15,20K,-3K,2000

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3700\$ FILE B*,B1R
3710\$ PRMFL SL,R,S,CACI/SIM2LIB
3720\$ PRMFL 17,R,S,CACI/SIMERR
3730\$ DATA 05
3740\$ SELECTA MFD
3750\$ ENDJOB

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A SIMULATION TO EVALUATE MULTIYEAR PROCUREMENT
ECONOMICS FOR SPARES ACQUISITION(U) AIR FORCE INST OF
TECH WRIGHT-PATTERSON AFB OH SCHOOL OF SYST.

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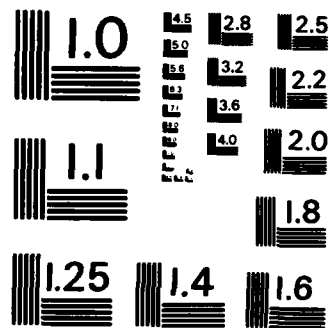
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Bibliography

1. Aeronautical Systems Division. B-1B Systems Program Office, B-1B Multiyear Briefing, 1984.
2. Aeronautical Systems Division. B-1B Systems Program Office, Contract F33657-81-C-0212 with Boeing Company; Provisioned Item Order F22020-83-4401, 17 January 1984; Repair Level Analysis, 25 January 1984.
3. Aeronautical Systems Division. B-1B Systems Program Office, B-1B Logistics Directorate, Point Paper, 3 November 1983.
4. Air Force Logistics Command. Air Force Provisioning Fundamentals Part One. AFLCR 65-1. 28 March 1980.
5. Belyea F. S. "Effectiveness of Multiyear and Advance Procurement Contracts," 115-117 (1983).
6. Boeing Company, Trip Report on Provisioning Conference, 30 Sept. 1983.
7. Brabson, Colonel G. Dana. "Can We Afford the DOD Acquisition Improvement Actions?," Concepts, 5 Number 1:45-55 (1982).
8. Brearey, Major Jonathan L., "An Analysis of the Impact of Multi-Year Procurement On Weapon System Acquisition," AFIT Thesis, LSSR 62-81: 1-137 (1981).
9. Crosby, Captain Michael L., Rowland, Captain Ford W. "A Multiyear Procurement Feasibility Study for the T-46A," AFIT Thesis, LSSR 87-83:1-103 (1983).
10. Department of the Air Force. Spares Acquisition Integrated With Production. AFR 800-26, 17 February 1978.
11. Fromer, Harvey S., Sweeney, John L. "Multi-Year Procurement A 'Team Approach'," 188-192 (1983).

12. Good, Debra E., "An Analysis of the Feasibility of Using Design Stability as a Decision Parameter For Making Logistics Supportability Decisions," AFIT Thesis, LSSR 84-83: 1-120 (1983).
13. Harshman, Richard A. "Multiyear Procurement in the First Reagan Defense Budget," Armed Forces Comptroller, 27 Number 3: 25-28 (1982).
14. Joseph, John, B-1B Avionics Engineer. ASD/B1EA, Wright Patterson Air Force Base, March 1985.
15. Lafors, Lieutenant Colonel Kary R. "Selecting Programs for Multiyear Procurement," Concepts, 5 number 2:54-67 (1982).
16. Lengel, Joau E. "Phased Provisioning," Logistics Management Institute, (1982).
17. Meyer, Deborah G. "Would You Pay \$30 for This Screw?," Armed Forces Journal International, 121 Number 2:40-44 (1983).
18. Rasch, Major Ronald H., Breary, Major Jonathan L. "Multiyear Procurement: A Current Perspective," Concepts, 5 Number 2: 39-53 (1982).
19. Sanders, Thomas R. Jr. "An Analysis of Multi-Year Procurement Cost Estimating Methods At The Aeronautical Systems Division," AFIT Thesis, LSSR 33-83:1-71 (1983).
20. Singer, Dr. Abraham, Brabson, Colonel G. Dana. "Enhanced Mutiyear Procurement for Improving Weapon System Acquisition," Concepts, 5 Number 3: 112-129 (1982).
21. Skantz, General Lawrence A. "Progress, Process, and Pitfalls A Survey of Air Force Acquisition Today," Program Manager, 13 Number 3: 2-8 (1984).
22. Slay, General Alton D. (Ret.). "A New Look at an Old Remedy: Multiyear Contracts and Defense Procurement," Defense Management Journal, First Quarter: 20-25 (1982).

23. U.S. General Accounting Office "Analysis of Benefits Realized From Multiyear Contracting For the Black Hawk Helicopter," 1-7 (1984).
24. U.S. General Accounting Office "Analysis Of DOD's Fiscal Year 1985 Multiyear Procurement Candidates," 1-31 (1984).
25. U.S. General Accounting Office "Issues Concerning The Department of Defense's Global Positioning System As It Enters Production," 1-16 (1983).
26. U.S. General Accounting Office "Logistics Support Costs For The B-1B Aircraft Can Be Reduced," 1-38 (1984).
27. Villanueva, R., Kiviat, P. J., Markowitz, H. M., SIMSCRIPT II.5 Programming Language, Consolidated Analysis Centers Inc., edited by E. C. Russell. 1973.
28. Webster, Richard D. "Attacking Logistics Problems Through Acquisition Reform," Defense Management Journal, 18 Number 4: 3-8 (1982).

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The purpose of this ^{research} was to evaluate the economics of applying the Multiyear Procurement (MYP) contracting approach on spare acquisitions. Evaluations have been performed documenting upfront savings with the use of MYP. Savings have been shown in the areas of material purchases and inflation avoidance. However, no research has looked into the downstream cost implications associated with MYP. The B-1B program issued MYP contracts for many of their spare requirements in order to obtain the expected benefits. This research concentrated on selected items covered in those contracts. The risk areas were determined to be costs associated with engineering changes, transportation, storage, program changes, and quantity adjustments. A simulation model was developed that can be used on any weapon system program to evaluate the benefit/cost relationships of MYP. Findings were that the two cost drivers in the MYP decision are the expected upfront savings compared to the expected engineering change costs. In addition, this research has shown that while MYP is appropriate for some items, it is not the correct approach for all items. The decision must be evaluated on each weapon system program individually. The simulation model provides this capability.

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